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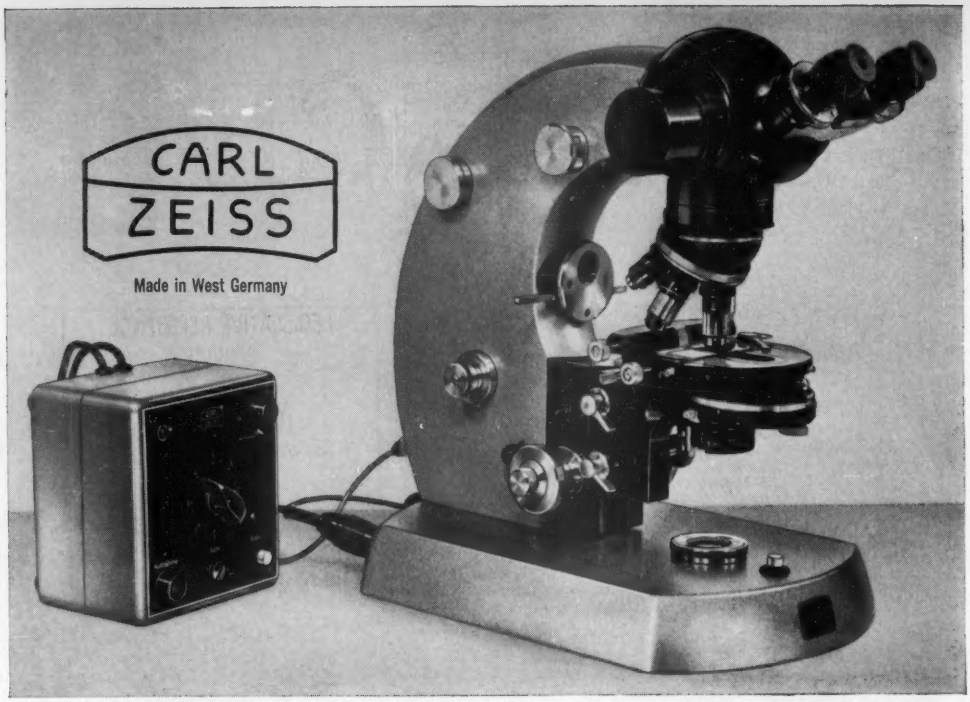

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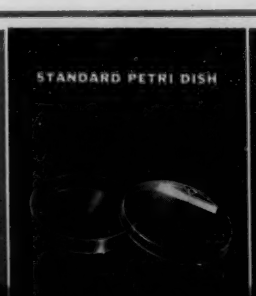

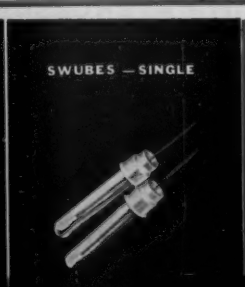

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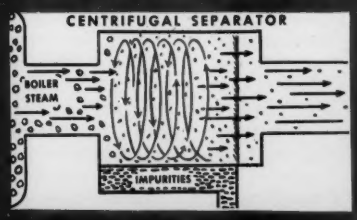

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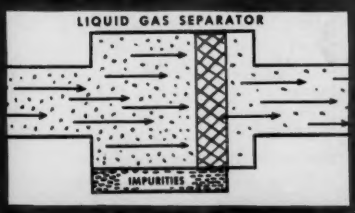

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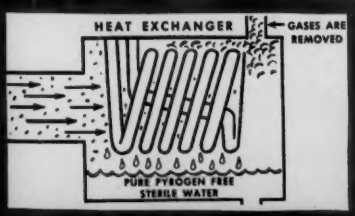

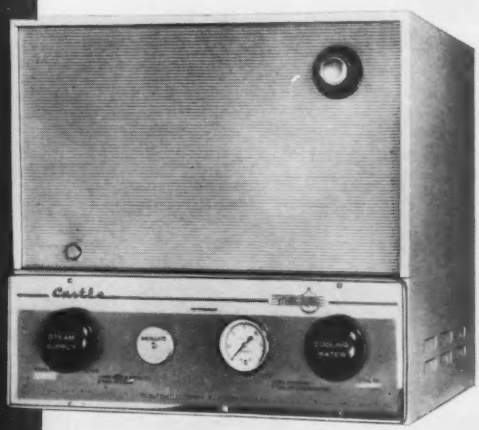

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Letters

Education of Science Teachers

The recent exchange of letters on the education of science teachers [*Science* **129**, 744 (1959)] has shown clearly that a major point of disagreement between educationists and their opponents concerns the utility of education courses. On the one hand, the educationists assert that teaching is a profession which requires special, professional training; on the other hand, many people feel that anyone who knows his subject well can teach it satisfactorily. In practical terms, the question is: Can a college graduate teach as well, in his major subject, as a graduate with the corresponding degree in education? And, more generally, what mixture of education courses and "content" courses will produce the best teacher?

Both sides have produced arguments to support their views, but there has been very little objective evidence to support either view. What evidence there has been is one-sided, rather than comparative. Thus, the educationists ask, "Can 50 years of research in education be ignored?" while their opponents point out that education courses are widely regarded by undergraduates as easy to pass and negligible in content. What is needed in order to remove the controversy from the realm of mere verbal sniping to that of informed and intelligent debate is a body of facts on the effectiveness of teachers who have been trained in different ways.

A direct way of obtaining this information would be to compare the scores, on a nationally administered series of tests, of two groups of students: those whose teachers majored in education and those whose teachers majored in the subject concerned, without taking any education courses. Such tests already exist, and teachers of the second type are already at work with temporary accreditation in many places. Thus it might be possible to obtain the desired information from statistics or other information which already exists; on the other hand, it might be necessary to set up an extensive experiment, selecting teachers and students with appropriate backgrounds in order to free the comparison from systematic effects which might distort results obtained from the existing data. (For example, if poor students tend to take education courses because they are "easy to pass," this must be allowed for in comparing the intrinsic utility of education *courses* with that of "content" courses for training of teachers; but if we are interested in the relative effectiveness of education and "subject-matter" *graduates* as teachers, then such effects should be ignored.)

Until some such study is made, I do not see how the present controversy can be anything more than a difference of opinion which, for lack of evidence, cannot be resolved.

ANDREW T. YOUNG
11 Buena Vista Park,
Cambridge, Massachusetts

Luminous Wrist Watches

Joyet [*Bull. acad. suisse sci. méd.* **14**, 367 (1958)] reports that the average man's luminous wrist watch contains 0.36 μc of radium and the average woman's watch, 0.13 μc, both being of the type in which the entire dial is painted. A man wearing such a watch 24 hours a day receives a gonadal dose of about 21.8 mr/yr, and a woman receives about 12.7 mr/yr, as measured by Joyet.

A sample of 224 persons (a group of Government employees in New York City in all of the occupation categories and levels represented) was investigated. Questions were asked and observations were made as to type of watch and wearing habits, with the results given in Table 1.

When Joyet's results were combined with the results for this sample of New Yorkers, it was found that the average gonadal exposure of the 224 persons is calculated to be 3.83 mr per year per person. The fact that very few, if any, persons in the age group up to age 30 or 35 wear watches for the first 10 or so years of life should not be ignored. This would tend to reduce the figure 3.83 to about 2.5 mr/yr. This reduction might be offset slightly by the fact that, of the luminous watches worn, a larger fraction is worn by younger than by older adults. This was a general observation, and findings were not tabulated.

If we assume, then, that the average annual dose is about 3 mr from birth to age 35, the 35-year dose will be about 0.1 r, as compared with the estimate by Laughlin and Pullman of 0.03 r (range 0 to 0.3 r) given in the National Acad-

Table 1. Data on the wearing of luminous watches from a survey of 224 Government employees in New York City.

Item	Men	Women
Total number questioned	148	76
Number wearing watches of all types	114	57
Number wearing luminous dial watches:		
Less than 10 hr/day	0	0
10–19 hr/day	34	2
19–24 hr/day	16*	0

* Only one watch found with luminous points (Joyet's category P).

emy of Sciences report of 1956. This amounts to about 3 percent of natural background radiation and only about 1.5 percent of the total radiation dose derived from background plus medical and dental exposure to the gonads, as currently estimated.

HANSON BLATZ
City of New York Department of Health, New York

Ruth Benedict

Julian Steward, in his long and prevailingly generous review [*Science* **129**, 322 (1959)] of *An Anthropologist at Work, Writings of Ruth Benedict,* raises three issues which seem to call for clarification. He interprets my discussion of Ruth Benedict as a "figure of transition" as referring to her role in linking together the Boas period of anthropology and one small segment of contemporary culture and personality research known as "national character." I did not use the term in any such parochial sense, but rather in reference to the whole intellectual climate of opinion of the second quarter of the twentieth century.

Steward asks why I did not mention the Kardiner-Linton seminar held at Columbia University in the late 1930's. At the time that Abram Kardiner independently began to apply psychoanalytic theory to the study of culture, the major theoretical lines for the study of personality and culture (as in John Dollard's *Criteria for the Life History*) had already been worked out by Roheim, Sachs, Fromm, Erikson, Frank, Dollard, Sapir, Gorer, and myself, and Ruth Benedict was already familiar with them. Kardiner's one new contribution—his theory of primary and secondary institutions—neither she nor I found useful. Although it is uncertain to what extent Ralph Linton mediated the existing literature to Kardiner, I have always regarded Kardiner's work as an example of historical parallelism.

On the third point, the extent to which Steward feels that the Columbia University department of anthropology was, during his membership in the department, a continuation of the Boas tradition, Steward himself is surely the best authority.

MARGARET MEAD
American Museum of Natural History, New York

Winchester's Genetics

In a review of A. M. Winchester's book, *Genetics* [*Science* **129**, 91 (1959)], the reviewer dismissed the book as one that he could not recommend for use by students of the subject. He commented that the book was apparently written for college students with little formal education, and he seemed to imply that there was something wrong with such a text being anthropocentrically oriented. Since the book was published by a distinguished publishing house, and the series in which it appears is edited by a geneticist who was also then a member of the Editorial Board of *Science,* it seemed to me that something must be awry somewhere. I therefore sent for a copy of Winchester's book, and having read it I have now satisfied myself where things went awry. They went awry with the reviewer. He committed the cardinal sin of reviewing, namely, reviewing a book at a level for which it was not written and at which it was never intended to be read. The author quite clearly sets out the classes of readers for whom the book is intended: the nonspecialist student in genetics, the student of psychology, sociology, or medical science, and those wishing to take the course as an elective or as a part of a general education program.

As one who has had to learn his genetics from books, and who has read a representative number of them over the course of the years, I should like to protest the reviewer's unfair dismissal of this book, and to go on record as saying that Winchester's book is, in my opinion, a book eminently well suited to meet the requirements of a first and perhaps only course in genetics for the student who is not specializing in the subject. The text is clearly and soundly written, the illustrations, tables, and figures are clear and quite generally most interesting in themselves, and the problems are most helpfully constructed. The orientation toward man makes the book unusually interesting.

ASHLEY MONTAGU
321 Cherry Hill Road, Princeton, New Jersey

While it is true that Winchester's book is meant to appeal to students of varied backgrounds, it is apparently meant for biology students as well. This point, however, is really quite unimportant, for the real issue is whether any textbook that treats its subject in a trivial and superficial manner should be used in any course in our universities.

Montagu is entitled to his opinion of the book, but his obvious appeal to the authority of a member of the Editorial Board of *Science* is unworthy of serious comment. I am sorry, however, that I have piqued the sensibilities of an anthropologist by complaining about the excessive anthropocentric orientation of a textbook of genetics.

S. R. GROSS
Rockefeller Institute, New York

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National Goals for Education

The accelerating rate of change in our society poses difficult questions for education. Our children must be educated not for living in the present world but for living in the unpredictable world of the future. No recent report on education has shown a clearer grasp of the implications of change than has that of the Panel on Science and Engineering Education of the President's Science Advisory Committee ("Education for the Age of Science," Government Printing Office, Washington 25, D.C. 20¢).

The report is remarkable not so much for the novelty of its suggestions—all of them have been made in more or less similar form before—as for its sharp focus on the needs of the future, for its broad, well-balanced approach to the proper goals of education, and for its vigorous recommendations about what ought to be done to improve the education of children and adults.

The report calls for a doubling of the present expenditure for education; for greater support of education in all of its branches rather than merely in science and mathematics; for imaginative approaches to the education of adults in the sciences, to prepare them for making policy decisions in which scientific considerations will play an ever larger part; for more scientific education for girls and women; for higher standards and better community status for teachers; for greater utilization of advanced placement courses in the high schools; for experiments with audiovisual aids in teaching; for improvement and modernization of textbooks and laboratory equipment; for greater cooperation between college and university teachers and their high-school colleagues; for strengthening of engineering schools and engineering curricula; for a more rigorous high-school program; and for recognition and educational support of the intellectually talented.

What influence will the report have? The status of the panel that wrote it and the refreshingly straightforward style in which it is written should assure it a large number of readers. In addition, the panel plans to give the report wide circulation among colleges and high schools and their governing boards, so that those who are most directly concerned with education will have a chance to see it.

Even though most of those who read the report will agree with all or many of the recommendations, they will look in vain for more than hints about how they may be put into effect. Aside from an occasional plea that some foundations or some government agencies might act on some of its recommendations, the report is silent. The report, to take one example, states that no able students should be forced to discontinue their education for economic reasons and that "the nation as a whole should take the responsibility for seeing that they are permitted to make themselves as useful as they can become." And elsewhere the report urges that "measures be evolved to discover and provide financial support for bright students whose needs cannot be met in their local community, and to make it possible for them to study in more adequate schools."

Throughout the report it is made clear that education is a national rather than a purely local concern and that intellectual talent is our greatest national asset—an asset that should be developed to its fullest potential no matter where it is found. Fine, but who is going to be responsible for the development of talent? Local governments? Foundations? The Federal Government?—G.DuS.

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Cenozoic History of the Bering Land Bridge

The seaway between the Pacific and Arctic basins has often been a land route between Siberia and Alaska.

David M. Hopkins

Many facts of paleontology and biogeography (*1, 2*) indicate that the Old and New Worlds have sometimes been connected by a continuous land route that extended from Alaska across the present shallow floors of the Bering and Chukchi seas (Fig. 1) to Siberia. Recent geologic studies in western Alaska permit a more detailed consideration of the times at which the land bridge existed during the last 50 million years of Tertiary and Quaternary time. Some well-founded inferences can also be drawn concerning the climate and vegetation that prevailed on the land bridge during the last (Wisconsin) glacial interval, the most recent period during which the land bridge existed (*3*).

Character of the Sea Floor

The floor of the northeastern Bering Sea, Bering Strait, and Chukchi Sea is a wide platform extending from the Alaskan to the Siberian coast, covered by 100 to 500 feet of water (Fig. 2). The platform is separated from the much deeper floor of the western Bering Sea by a submarine escarpment more than 5000 feet high. A less abrupt escarpment descends from the northern edge of the Chukchi platform to the depths of the Arctic Ocean.

The Bering-Chukchi platform is monotonously flat. St. Lawrence Island, St. Matthew Island, the Pribilof and Diomede islands, and several smaller islands near the coast of Seward Peninsula are the only prominent topographic highs in the Bering Sea and Bering Strait. Herald Shoal, 42 feet deep, lies in the central Chukchi Sea. Aside from these, the surface of the platform is devoid of sharply defined topographic features. Bottom gradients are so small that they are difficult to measure (*4*, pp. 2–4). No features are recognized that can be interpreted as submerged valleys or submerged strand lines (*5*).

The nearly featureless topography of the surface evidently results from intense marine sedimentation during the last few thousand years (*6*). Very gentle slopes underlain by fine sand radiate from the mouths of the Yukon and Kuskokwim rivers, and a gently sloping ramplike surface underlain by fine sandy mud descends from the mouths of the Kobuk and Noatak rivers, through Kotzebue Sound, to the deeper part of the Chukchi Sea. The flat surface beneath the northwestern Bering Sea and the central Chukchi Sea is underlain by silt and clay containing numerous ice-rafted pebbles. Hydrogen sulfide is reported in many bottom samples from Chukchi Sea; its presence suggests rapid deposition in a reducing environment. Bering Strait has a sandy and rocky bottom that lies slightly below the general level of the adjoining parts of the Bering-Chukchi platform. The overdeepening and the coarser bottom sediments probably result from the strong, north-setting currents that pass through the strait.

Though the Bering-Chukchi platform happens to be a marine basin at present, the crustal structure below the veneer of young marine sediments resembles the structure of continental areas rather than the structure of typical ocean basins (*7*). Most of the present islands in the Bering Sea and Bering Strait are composed of typical continental rocks similar to those in parts of Siberia and Alaska.

Striking evidence for the structural continuity of the western Alaska and eastern Siberia land masses is provided by a comparison of the bedrock stratigraphy and structure of Wrangell Island on the continental shelf north of Siberia with the stratigraphy and structure of Lisburne Peninsula in northwestern Alaska (Fig. 3). Both areas are underlain by ancient sedimentary rocks of similar age, sequence, and character [compare geologic maps of Alaska and eastern Siberia (*8, 9*).] East-trending folds and faults that record the thrusting of older rocks northward over younger rocks on Wrangell Island correspond to south-southeast-trending folds and faults that record the thrusting of older rocks eastward over younger rocks on Lisburne Peninsula. The two areas evidently represent segments of a single mountain arc which once straddled the continents and is now partly submerged, extending from Wrangell Island eastward through Herald Island (in the Chukchi Sea), southeastward through Herald Shoal, and south-southeastward across Lisburne Peninsula.

The geological evidence indicates quite clearly that Siberia and Alaska represent segments of a single continental mass, separated by a segment only temporarily submerged, the Bering-Chukchi platform. Paleontological evidence indicates, however, that the land connection has been interrupted by tem-

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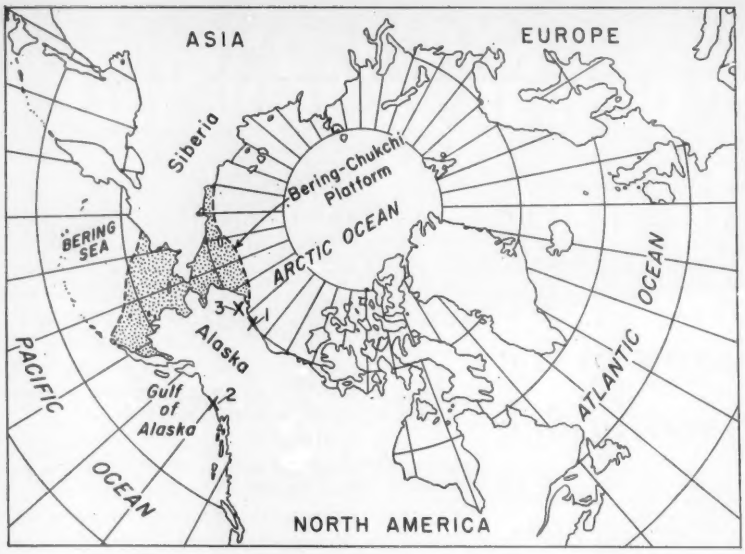


Fig. 1. The Bering land bridge as a barrier to marine organisms. Late Tertiary molluscan fauna at Camden Bay (1) on the Arctic coast of Alaska resembles contemporary faunas from the North Atlantic Ocean and differs sharply from contemporary faunas from the Gulf of Alaska (2); the Bering-Chukchi platform must have been a land barrier separating the Arctic Ocean from the Pacific Ocean when the Camden Bay fauna was living. The first opening of a marine connection between the Pacific Ocean and the Arctic Ocean is recorded by the *Neptunea* complex from the Gubik formation along the lower Colville River (3).

porary submergence in this area several times during the last 50 or 60 million years.

Land Bridge

Nonmarine sediments of Eocene age (containing *Sequoia* and other plant remains) are found on St. Lawrence Island (*10*), and marine sediments tentatively assigned a Pliocene age are found in several localities on Seward Peninsula (*11*) and on the Pribilof Islands (*12*). Aside from these isolated occurrences, no Tertiary sediments (1 to 60 million years old) have yet been surely identified in western Alaska north of the Aleutian chain. Consequently we must continue to rely, for a while, upon indirect evidence —evidence for and against intercontinental and interoceanic faunal migrations— in attempting to piece together the Tertiary history of the land bridge.

Simpson shows that major faunal interchanges took place between the continents and thus that a land connection existed in early Eocene, late Eocene, early Oligocene, late Miocene, and middle-to-late Pliocene time (*1, 13*). An almost complete lack of interchange during middle Eocene time seems to indicate the temporary existence of a water barrier on the Bering-Chukchi platform; reduced interchange during later Tertiary time may merely reflect the existence of unfavorable conditions for faunal migrations through the area of the land bridge (*1*, pp. 654–656).

A land bridge for vertebrates is, of course, a land barrier to marine organisms. The existence of such a barrier in the Bering-Chukchi region throughout most of Tertiary time is indicated by molluscan faunas that show no relationship to contemporaneous Atlantic faunas in sediments of early, middle, and late Tertiary age along the coast of the Gulf of Alaska (*14*) and by a molluscan fauna closely related to faunas of middle Tertiary age from the North Atlantic in beds of Miocene or Pliocene age at Camden Bay on the arctic coast of Alaska (*15*) (Fig. 1). Evidently molluscan populations dwelling in the North Atlantic could migrate freely across the northern edge of North America to the arctic coast of Alaska but were denied access to the North Pacific by a land barrier in the area of the Bering-Chukchi platform.

We may conclude that the area of the Bering and Chukchi seas lay above sea level throughout most of the last 50 or 60 million years. Water barriers between the continents existed only briefly, if at all, from middle Eocene until middle Pliocene time, and they resulted from crustal warping. The present basins of the Bering and Chukchi seas could not have come into existence until after the major exchange of land vertebrates that took place during middle-to-late Pliocene time, a few million years ago.

Initiation of Seaway

At some remote time near the beginning of the Pleistocene epoch, approximately a million years ago, the Bering-Chukchi platform was depressed, the Bering and Chukchi coasts of Alaska assumed approximately their present forms, and the water barrier between the continents came into existence. The outline of the original marine basin is recorded today by an abandoned wave-cut cliff that is traceable, with minor interruptions, from the Arctic Coastal Plain of Alaska southward to the Yukon River; a similar feature can be traced around the perimeter of isolated bedrock highlands on St. Lawrence Island (Fig. 3) (*16, 17*). The ancient wave-cut cliff is separated from the present strand by coastal lowlands ranging in width from a few hundred feet to a few miles; all marine sediments of Pliocene or Pleistocene age known in western Alaska lie seaward of the cliff.

In most areas in northwestern Alaska the cliff marks the abrupt coastward termination of a rolling upland that evidently represents an ancient erosion surface, now deeply dissected by valleys graded to present sea level (*18*). A similar rolling surface forms the summit of the isolated bedrock highlands of St. Lawrence Island and the cliffed islands off the coast of Seward Peninsula.

The old wave-cut cliff has not been positively identified and may be absent along the Alaskan coast south of the Yukon River; it is probable, nevertheless, that the southern part of the Bering-Chukchi platform was submerged at about the same time, for the earliest recognized molluscan faunas lying seaward of the cliff in the north are closely related to faunas of the same age from the Pribilof Islands and the Pacific Ocean.

The time at which the Bering-Chukchi platform was depressed to form a seaway connecting the Pacific Ocean with the Arctic Ocean is established with fair precision by stratigraphic evidence con-

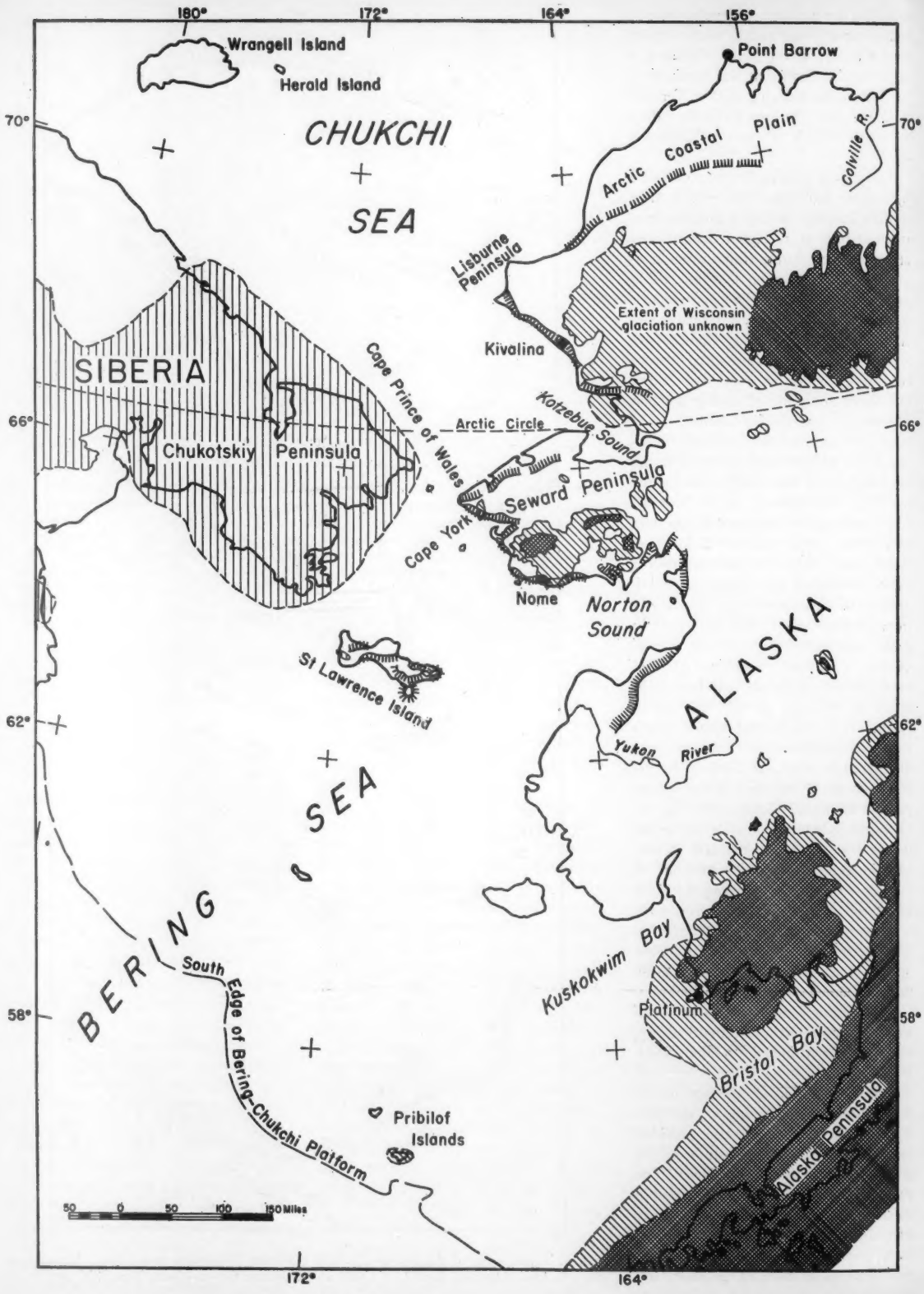
tained in the famous gold-bearing marine sediments at Nome and by recent studies of the history of the genus *Neptunea*, a large marine snail that was confined to the Pacific basin during most of Tertiary time and that first appears in the Atlantic basin in beds of earliest Pleistocene age.

The coastal plain at Nome is underlain by marine sediments that record three distinct intervals during which sea level stood as high as, or higher than, it does at present and during which water temperatures were warmer than they are at present (*11, 19, 20*). The two younger sets of marine sediments probably accumulated during the last (Sangamon) and the next-to-last (Yarmouth) Pleistocene interglacial intervals. The oldest may have accumulated during the first (Aftonian) interglacial interval, or it may have accumulated at about the beginning of Pleistocene time, prior to the lowering of sea level that accompanied the first (Nebraskan) glacial interval. The earlier age is suggested by the fact that these oldest marine deposits at Nome have yielded a mollusk, *Pecten hallae*, belonging to a subgenus (*Fortipecten*) that was previously known only from sediments of Pliocene age in Japan and Sakhalin (*11*), and a foraminifer, *Pseudopolymorphina ishikawaensis*, known previously only from sediments of Miocene or Pliocene age in Japan (*21*). The second known North American occurrence of *Fortipecten* was discovered in 1957, far north of Bering Strait, at the inner edge of the coastal plain at Kivalina, Alaska (*22*) (Fig. 3).

Marine sedimentation at Nome began, then, during or before the first Pleistocene interglacial age. The presence of *Fortipecten* and *Pseudopolymorphina ishikawaensis* in the oldest marine sediments at Nome and of *Fortipecten* at Kivalina indicates that by late Pliocene or early Pleistocene time a new seaway extended across the Bering-Chukchi platform, affording a migration route northward for marine organisms that had previously been confined to the North Pacific Ocean.

Evidence bearing on the age of the late Cenozoic submergence of the Bering-Chukchi platform is also provided by an unpublished recent study of the genus *Neptunea* by F. S. MacNeil: "The genus *Neptunea* apparently originated in the Pacific Ocean during early Tertiary time. Its earliest occurrences in the Atlantic province are in the basal Pleistocene deposits of England, Belgium, and

Fig. 2. Topography of the Bering-Chukchi platform (Mercator projection). Depth contours in feet. [Modified from U.S. Coast and Geodetic Survey charts Nos. 9032 and 9400]


180°
172°
164°
156°
Wrangell Island
Herald Island
Point Barrow
70°
CHUKCHI
SEA
Arctic Coastal Plain
Colville R.
Lisburne Peninsula
Extent of Wisconsin glaciation unknown
Kivalina
SIBERIA
Cape Prince of Wales
Kotzebue Sound
66°
Arctic Circle
Chukotskiy Peninsula
Seward Peninsula
Cape York
Nome
Norton Sound
St Lawrence Island
ALASKA
62°
Yukon River
SEA
BERING
Kuskokwim Bay
South Edge of Bering-Chukchi Platform
58°
Platinum
Bristol Bay
Pribilof Islands
Alaska Peninsula
50 0 50 100 150 Miles
172°
164°

the Netherlands, where there is a variable population that contains varieties foreshadowing both of the living Atlantic species, the more northern *N. despecta,* and the more southern *N. antiqua.* An even larger and more variable intergrading population of *Neptunea* is found in the lower part of the Gubik formation along the Colville River in the Arctic coastal plain of Alaska [Fig. 1, location 3]. The collections from the lower Gubik formation include varieties similar to those originally found in Europe, as well as varieties that approach the typically North Pacific and Siberian living species, *N. ventricosa*" (*23*).

The sudden appearance of *Neptunea* at the beginning of Pleistocene time in Europe suggests that the genus had found a migration route from the Pacific to the Arctic basin a short time earlier, and the presence of possibly ancestral forms on the Arctic coastal plain of Alaska suggests that the lower part of the Gubik formation may be of late Pliocene or earliest Pleistocene age.

The available lines of evidence seem to agree in pointing to a submergence of the Bering-Chukchi platform near the end of the Pliocene epoch, approximately a million years ago. (i) The evidence of strong faunal interchange of land mammals between Eurasia and North America during middle and late Pliocene time indicates that the water barrier could not have come into existence until shortly before the beginning of Pleistocene time. (ii) The stratigraphic record at Nome indicates that the first marine deposits there were laid down during or before the first Pleistocene interglacial interval. (iii) The distribution in time and space of fossil *Neptunea* indicates that at, or shortly before, the beginning of the Pleistocene epoch a marine migration route opened, permitting molluscan populations from the North Pacific Ocean to invade arctic waters, and then spread along the northern margin of the continents into Atlantic waters; and (iv) the ancient wave-cut cliff lying at the inner edge of coastal plain areas throughout much of western Alaska marks the former shore of this early waterway.

Fig. 3 (at left). Pleistocene geology of western Alaska and eastern Siberia [Lambert conformal conic projection (*48*)]. The limits of glaciation are shown by a solid line (or by a dashed line where there is uncertainty).

Areas covered by ice during Wisconsin glacial stage.

Areas covered by ice during Illinoian glacial stage.

Areas in Siberia and Saint Lawrence Island covered by glacial ice of unknown age.

Old wave-cut scarp.

Sedimentation and Crustal Warping

One cannot assume, of course, that the surface topography of the Bering-Chukchi platform has remained unchanged throughout the lengthy period since it first submerged, near the beginning of the Pleistocene epoch. In the course of the long emergence during Tertiary time, a stream-sculptured topography must have developed that would now lie buried beneath the marine sediments that form the present monotonously flat sea floor. I believe that the rolling upland surface extending inland from the old wave-cut cliff throughout much of northwestern Alaska and the similar rolling surface that forms the summit area of the islands in Bering Sea represent remnants of this pre-Pleistocene stream-sculptured landscape persisting in areas that either formed highlands on the Tertiary land bridge or that were not involved in the general submergence that brought the Bering and Chukchi seas into existence. Herald Island and Herald Shoal appear to be submerged remnants of a low mountain range that once extended from Lisburne Peninsula, Alaska, to Wrangell Island, Siberia.

It is likely, then, that a stream-sculptured bedrock topography, having a relief of several hundred feet, lies buried beneath the Pleistocene and Recent marine sediments that mantle the Bering-Chukchi platform; it is also likely that the floors of the Bering and Chukchi seas have become progressively shallower, due to the deposition of marine sediments, during each succeeding interglacial interval of high sea level.

Crustal warping during Pleistocene time has affected the depth and extent of parts of the Bering and Chukchi seas; however, only along the south coast of western Seward Peninsula has the crustal disturbance been of a magnitude likely to affect the duration of temporary land connections between Siberia and Alaska during Pleistocene time. Even here, the effect of crustal warping has probably been to make Bering Strait shallower during successively more recent interglacial intervals.

The spectacular local deformation in western Seward Peninsula apparently results from repeated movement along an inferred fault that lies just offshore at Cape York and that may extend westward to or beyond Cape Prince of Wales, the eastern portal of Bering Strait (Fig. 3). In the Cape York–Cape Prince of Wales area, the ancient wave-cut cliff lies at the inner edge of a marine terrace as much as 3 miles wide that has been unevenly warped 300 to 750 feet above sea level (*17, 24*). The terrace is dissected by valleys graded approximately to present sea level, and the valleys contain glacial deposits of probable Illinoian (third glacial) age; thus, most of the crustal warping that resulted in uplift of the terraces took place prior to Illinoian time.

Elsewhere, the Alaskan coast south of the Yukon River appears to have been submerged by more than 100 feet during late Pleistocene time, probably as a result of isostatic adjustment to the heavy sediment load that has been delivered to the eastern Bering Sea by the Yukon and Kuskokwim rivers and to the weight of the large glaciers that invaded Kuskokwim Bay and Bristol Bay during Illinoian(?) and Wisconsin time (Fig. 3). The deeply indented fjord coast of southern and eastern Chukotskiy Peninsula may also have subsided in late Pleistocene time in response to a heavy load of glacial ice. Kotzebue Sound has been enlarged by slight tectonic subsidence of its southern shore east of Cape Espenberg (Fig. 2) since Illinoian(?) time (*25*).

Other parts of the Bering and Chukchi sea coasts appear to have remained relatively stable throughout Pleistocene time. Marine sediments containing faunas ranging in age from late Pliocene or early Pleistocene (*12*) to late Pleistocene (*26*) are found near present sea level on the Pribilof Islands, and old beach ridges recognizable on topographic maps are abundant below altitudes of 125 feet, and lacking at higher altitudes, on St. Lawrence Island, on the shores of Norton Sound, and along most of the Alaskan coast of Chukchi Sea.

The effects of sedimentation and crustal warping upon the depth and width of the Bering-Chukchi platform may be summarized as follows.

1) The deposition of marine sediments has tended to fill the marine basin and to lead to progressively shallower water during each succeeding interglacial interval.

2) Submergence due to isostatic loading of the Alaskan coast south of Norton Sound and of the south and east coasts of Chukotskiy Peninsula tended to widen and deepen the eastern and northwestern parts of the Bering Sea during late Pleistocene time. The submergence seems to have been localized in areas within a few tens of miles of the present coast, for St. Lawrence Island and the Pribilof Islands do not appear to have been affected.

3) Western Seward Peninsula is a tectonically active area. Deformation of the magnitude recognized between Cape York and Cape Prince of Wales would have resulted in appreciable changes in the depth of Bering Strait if the inferred coastal fault extends west of Cape Prince of Wales. Bering Strait may have been considerably deeper during early Pleistocene time than during late Pleistocene time.

One must conclude that a seaway at least as deep as the present one separated Siberia from Alaska during each Pleistocene interglacial interval and that the land bridge was open only when the surface of the sea lay considerably below its present level.

Fluctuating Sea Level

The repeated growth and disappearance of large glaciers during the Pleistocene epoch was accompanied by repeated changes in the position of sea level. The surface of the sea lay at least 100 feet higher than it does at present during the warmest interglacial intervals, when glacial ice disappeared almost completely throughout the world, and sea level was lowered by more than 300 feet during the most intense glacial intervals (*27*).

The application of radiocarbon dating to oceanographic and stratigraphic studies of late Pleistocene marine sediments has begun to yield a more detailed knowledge of the positions of sea level during the last 10,000 years and at least a sparse knowledge of positions of sea level during the preceding 30,000 years (Fig. 4). Curves showing the late Wisconsin and post-Wisconsin rise in sea level from – 180 feet to its present position are given with substantial agreement in at least three recent publications (*28*). Submerged shore-line features at depths of from – 150 to – 180 feet and from – 60 to – 80 feet in the Gulf of Mexico off the coasts of Texas (*29*) and Florida and Alabama (*30*) apparently record brief interruptions that occurred about 11,000 to 8000 years ago (*31*) in the otherwise steady and rapid late Wisconsin rise in sea level.

Most authors (*32*) have considered it probable that during earlier Wisconsin time sea level rose slowly but steadily from its lowest position (deeper than – 300 feet), held more than 35,000 years ago, to the position of – 180 feet, held 11,000 years ago; however, recently published radiocarbon dates from the Mississippi delta (*33*) seem to indicate that an initial rise from a depth of more than – 300 feet to a depth of less than – 150 feet (and possibly less than – 100 feet) was accomplished more than 35,000 years ago. The few radiocarbon-dated specimens having ages between 35,000 and 11,000 years, then, seem to record a renewed but lesser lowering of sea level to about – 200 feet during the interval from 25,000 to 13,000 years ago (*34*).

This modest reduction in sea level following an interval of relatively high sea level during middle Wisconsin time seems to be represented in a submarine drill core from Atchefalaya Bay, Louisiana, in which marine sediments 11,950 years old overlie the subaerially weathered surface of older marine sediments 27,700 years old at a depth of about – 110 feet (*35*). The evidence for relatively high sea level during the interval from 35,000 to 25,000 years ago, and for renewed lowering of sea level during the interval from 25,000 to 13,000 years ago, also accords closely with the radiocarbon-dated history of the final advance of the continental ice sheet from the vicinity of the Great Lakes to the Ohio River after middle Wisconsin time (*36*).

My interpretation of the history of sea level during Wisconsin time may be summarized as follows (see Fig. 4). Sea level was reduced more than 300 feet at the glacial maximum during early Wisconsin (Iowan ?) time, more than 35,000 years ago. Sea level then rose, apparently during an interval of relatively mild climates within the Wisconsin glacial interval, and seems to have been higher than – 150 feet during the interval from 35,000 to 25,000 years ago; the edge of the continental ice in North America at that time lay somewhere north of the Great Lakes (*37*).

The glacial advances of late Wisconsin time, reaching the latitude of the Ohio River, were reflected by a renewed lowering of the sea to a level of about – 200 feet. During the oscillating retreat represented by moraines of Tazewell, Cary, and Mankato age in the central United States, sea level rose again to a position between – 150 and – 180 feet. Submerged shore-line features at – 150 to – 180 feet in the Gulf of Mexico record a stable position of sea level about 11,000 or 12,000 years ago that may coincide with or may immediately precede the Valders of Thwaites (*38*) and Mankato readvances in the Great Lakes region.

A sharp warming of air and sea temperatures throughout the world from 11,000 to 9000 years ago was accompanied by an almost catastrophic retreat of the continental glaciers. Sea level rose to a new stable position, marked by submerged shore-line features at depths of – 60 to – 80 feet in the Gulf of Mexico; this position was occupied about 8000 years ago and may have coincided with or immediately preceded the readvance of the North American ice sheet to the vicinity of Cochrane, Ontario. The rapid rise in sea level began again about 7000 years ago, and sea level has lain within 10 feet of its present position throughout the last 5000 years.

Sea Level and the Land Bridge

The present-day surface of the Bering-Chukchi platform slopes so gently that changes in sea level of the magnitude recorded during the last 40,000 years would result in great modifications in the distribution of land and sea. A reduction in sea level amounting to 60 to 80 feet—the level at which sea level stood about 8000 years ago—would drain shallow indentations such as Norton Sound and Kotzebue Sound, and the west coast of Alaska would be considerably less deeply embayed (Fig. 5, A). If sea level were lowered 150 to 180 feet—the position recorded by submerged beaches 11,000 years old in the Gulf of Mexico—Bering Strait would be drained, and an intercontinental land connection would extend from St. Lawrence Island northward to the Diomede Islands (Fig. 5, C). If sea level lay only 120 feet below its present position—its approximate position 25,000 to 35,000 years ago—the continents would again be separated by a shallow channel locally only 20 miles wide (Fig. 5, B). A reduction in sea level of 300 feet—to the level recorded during early Wisconsin time more than 35,000 years ago—would result in the exposure of nearly all of the Bering-Chukchi plat-

form, and Alaska and Siberia would be joined by an almost featureless plain extending nearly 1000 miles from the north shore of a shrunken Bering Sea to the south shore of the Arctic Ocean (Fig. 5, D).

Sedimentation on the Bering-Chukchi platform has been intense and rapid since the latest inundation by the rising sea, and the surface that was exposed during the last period of low sea level evidently lies buried beneath a cover of Recent marine sediments at least several tens of feet thick. Thus the intercontinental land connection may have been inundated still earlier in the course of the late glacial rise in sea level than is suggested by the present topography of the sea bottom.

Comparison of the sea floor topography with recorded fluctuations in sea level, then, suggests that (i) a land bridge more than 1000 miles in north-south width connected Siberia and Alaska during the most intensely glacial phase of early Wisconsin time, over 35,000 years ago; (ii) the land connection was greatly narrowed and probably severed when sea level rose to within less than 150 feet of its present position during a cool but prolonged middle Wisconsin interglacial interval, 25,000 to 35,000 years ago; (iii) the land connection resumed or widened again when sea level fell to about – 200 feet during the late Wisconsin glacial advances, from 25,000 to 12,000 years ago; (iv) the land bridge was closed by the rising sea for the last time between 10,000 and 11,000 years ago.

The land bridge ceased to exist at a time when world climates still were far

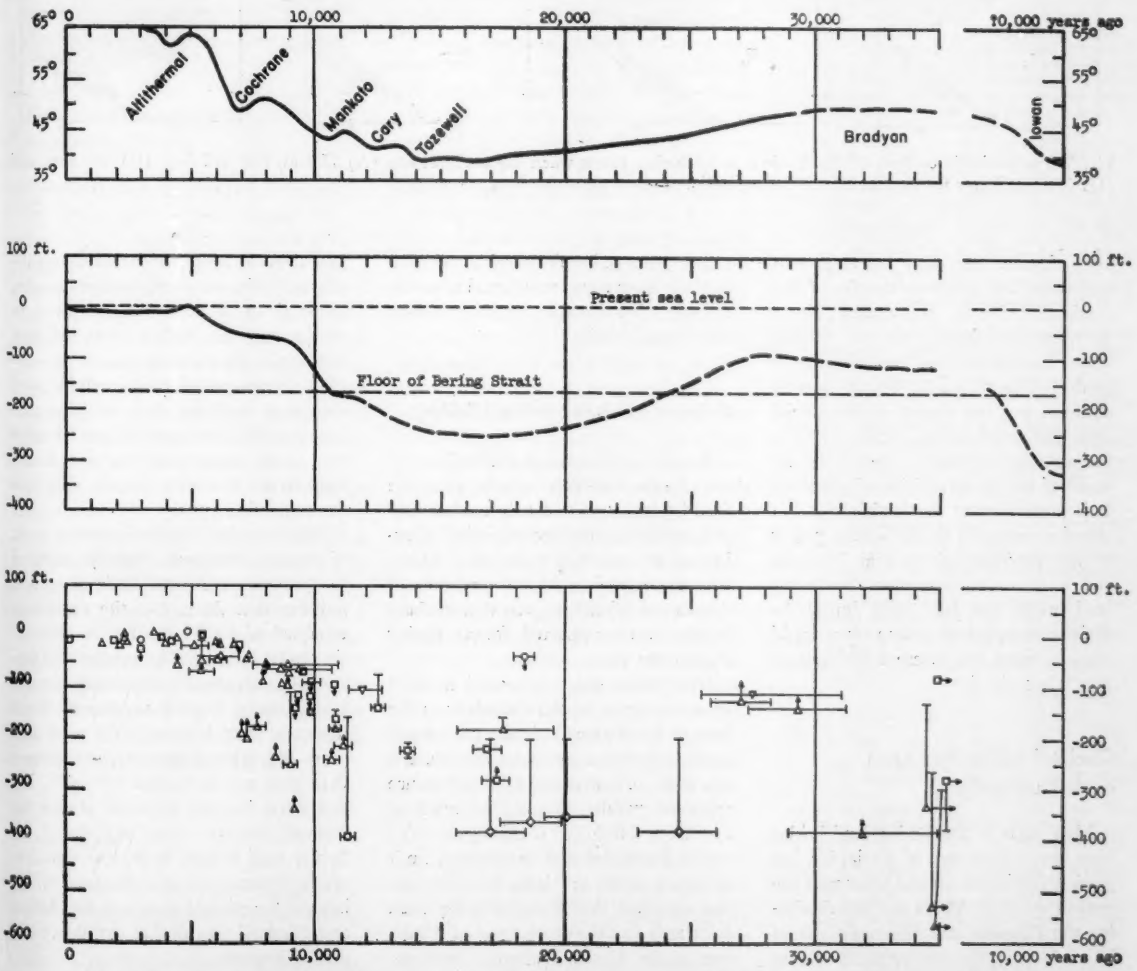


Fig. 4. Changes in sea level compared with fluctuations in the position of the margin of the continental ice sheet during and since the last glacial interval (*49*). (Top) The heavy line represents the position (latitude) of the southern limit of the continental ice sheet in North America. (Middle) The heavy line represents the position of sea level at various points in time. (Bottom) Past positions of sea level are indicated by radiocarbon dating of various specimens. The type of specimen is indicated as follows: (triangle, vertex up) shell; (square) wood; (circle) peat; (triangle, vertex down) organic residue in marine mud; (diamond) calcareous algae. The specimens are plotted at the depths at which they were collected. The vertical arrows indicate that the sea level was either lower or higher than the specimen. The vertical bars indicate the probable position of the sea level when the specimen was deposited. The horizontal bars indicate probable limits of dating error. The specimens without bars have a probable error too small to plot. A horizontal arrow indicates that the specimen is older than 35,000 years.

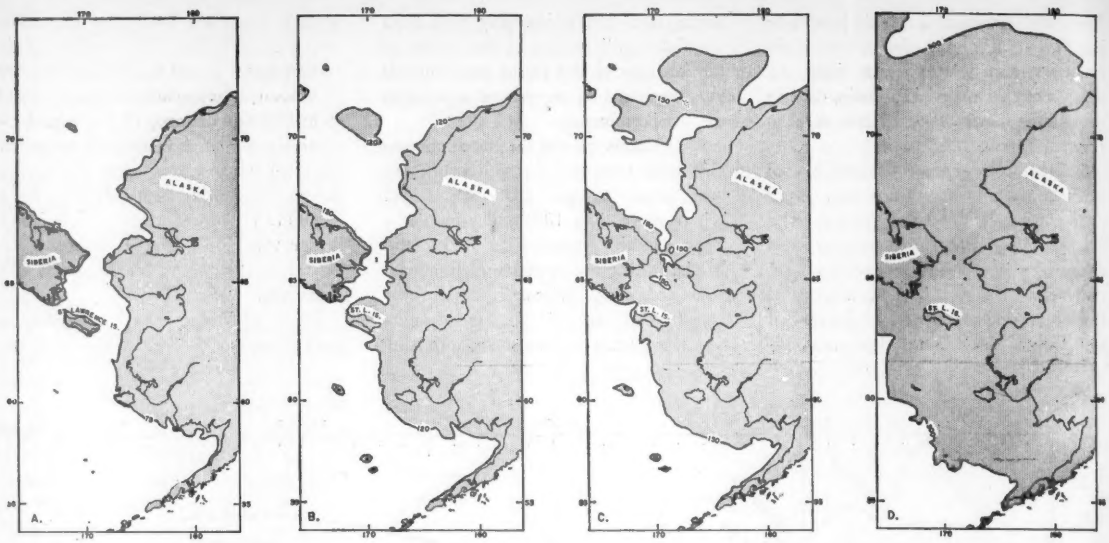


Fig. 5. The probable outlines of the Alaskan and Siberian coasts when the sea level was (A) 75 feet, (B) 120 feet, (C) 150 feet, and (D) 300 feet below the present level. Shading indicates areas above sea level.

more rigorous than they are at present and when the southern margin of the continental ice in east-central North America still stood near the United States–Canada border. The thickness of marine sediments on the Bering-Chukchi platform was less during earlier glacial ages, and consequently, smaller areas of the platform lay high enough to be exposed at any given position of sea level. It is probable that the land bridge was closed even earlier in the waning phases of the pre-Wisconsin glacial intervals, and it seems unlikely that the Bering land bridge was ever open during the Pleistocene epoch at a time when world climates were less severe than those of late Wisconsin time.

Glaciated and Ice-Free Areas on the Land Bridge

Most parts of the Bering land bridge have always been free of glacial ice, but glaciers did invade several areas near the present shores of Alaska and Siberia during the Illinoian and Wisconsin glacial intervals (Fig. 3) and probably during earlier glacial intervals. Small, local glaciers have existed in the past on St. Lawrence Island and possibly on the Pribilof Islands (*26*). However, even when the more extensive Illinoian glaciation was at its height, a broad ice-free corridor extended from central Alaska across the land bridge to eastern Siberia. Glaciers may have barred access to the central parts of North America and Asia, but they have never constituted a barrier to migration between eastern Siberia and central Alaska.

Forest or Tundra of the Land Bridge?

Recent paleobotanical studies in western Alaska establish clearly that the land bridge supported only treeless tundra during its most recent period of existence in late Wisconsin time. Moreover, a comparison of the vegetation of Alaska and Siberia suggests that the land bridge never supported forests during Pleistocene time.

The present-day continental limit of spruce forest in Alaska extends from the base of the Alaska Peninsula northward, parallel to the present coast but inland a few miles, to Kotzebue Sound and thence eastward, parallel to and a bit north of the Arctic Circle (*39*). During the Wisconsin glacial interval the western limit of spruce forest in Alaska lay even farther eastward. Pollen studies in the Cook Inlet area (on the south coast of Alaska east of the Alaska Peninsula) indicate, for example, that the first vegetation to take root on glacial drift of Wisconsin age consisted of treeless tundra and that the first trees did not appear until several thousand years after the area was deglaciated and after the Bering land bridge was drowned by the rising sea (*40*). Griggs has shown, moreover, that the spruce forest has been extending rapidly westward into tundra areas on the Alaska Peninsula during recent decades; the edge of the forest in southwestern Alaska now lies farther westward than it has lain for many thousands of years (*41*). Fossil pollen contained in pond sediments overlying drift of Wisconsin age near Platinum, several tens of miles west of the present limit of spruce in the Kuskokwim Bay area, records only tundra vegetation (*42*).

Paleobotanical studies in several parts of Seward Peninsula that lie west of the present continental limit of spruce, indicate that there, too, the vegetation consisted of tundra during the Wisconsin glacial interval. The continental timber line advanced temporarily several tens of miles beyond its present limits during a brief interval 8000 to 10,000 years ago, when summers were warmer than they are at present (*20, 43*), but this warm interval began at almost the moment that the rising sea closed the Bering land bridge. It is clear that forests never extended onto the land bridge beyond the present shores of the Bering and Chukchi seas during the Wisconsin glacial interval.

Little direct evidence is available concerning the character of the vegetation on the land bridge during its earlier periods of existence in Pleistocene time. However, comparisons of the living vegetation of Alaska and eastern Siberia and of the fossil floras of Pleistocene age known from both regions suggest that the tundra vegetations of the two con-

tinents have merged repeatedly and recently but that the forest vegetations have not been in contact with one another for a long time, probably not since the beginning of Pleistocene time. The tundra vegetation is made up largely of circumboreal species ranging widely on both continents (*44*), but no tree species is recognized as occurring in both Siberia and Alaska (*45*). In even the oldest of the Siberian Pleistocene floras the forest elements are Asiatic (*46*). The evidence of plant geography seems to indicate that the Bering land bridge has supported only tundra vegetation and that no continuous belt of forest ever extended across the land bridge from Siberia to Alaska during the Pleistocene epoch.

Pleistocene Climates on the Land Bridge

Several lines of evidence point to the conclusion that a severe arctic climate prevailed on the Bering land bridge during the Wisconsin glacial interval and presumably during the earlier periods of its existence within the Pleistocene epoch. The conclusion that the land bridge existed only during major glacial intervals leads to the inference that the climate there was at least as severe as the present climate around the shores of Bering and Chukchi seas. The paleobotanical evidence that the land bridge supported only tundra vegetation is most easily explained if one assumes that summers were too short and too cold to support forest vegetation (*47*). Finally, studies of fossil frost features on Seward Peninsula indicate that during the Wisconsin glacial interval summers were shorter and colder than they are at present, that winters were as severe as at present, and that snowfall in lowland areas was thin and patchy (*20*).

Conclusions

The interpretation of the Cenozoic history of the Bering land bridge offered in this article, resting as it does upon a synthesis of fragmentary data from many areas and several disciplines, must be regarded as tentative and rather speculative. Each new collection of Cenozoic mollusks from western Alaska, each new stratigraphic study of another coastal-plain area along the Bering or Chukchi coast, each new radiocarbon date relating to a position of sea level, can force some modification of the history as I have interpreted it. Much could be learned from submarine cores on the Bering-Chukchi platform deep enough to penetrate through the Recent marine sediments into older deposits. The most serious gap in present knowledge, however, is the lack of data on the stratigraphy and structure of the sediments in the deformed marine terraces of western Seward Peninsula adjoining Bering Strait; future studies in this area may result in profound modifications of the history that I have proposed here.

Though uncertainties persist, to be resolved by future work, these generalizations accord with the information now available. (i) The data of vertebrate paleontology suggest strongly that a seaway existed across the Bering-Chukchi platform during middle Eocene time, but physical evidence of its existence has not yet been found in Alaska or on the islands of the Bering Sea. (ii) The Bering-Chukchi platform was a land area during most of the remainder of the Tertiary period. (iii) A seaway across the Bering-Chukchi platform came into existence after middle Pliocene time and earlier than the beginning of the Pleistocene epoch. (iv) The continents were separated by a seaway on the Bering-Chukchi platform during each interglacial interval of the Pleistocene, and they were connected by a land bridge during each glacial interval. (v) Rising sea level eliminated the land bridge for the last time between 10,000 and 11,000 years ago. (vi) During Wisconsin time the land bridge had an arctic climate characterized by cold summers and severe winters; it supported treeless tundra vegetation; and animals migrating between the continents had to adapt to life in a tundra environment. The same conclusion is applied, with less conviction, to intercontinental land connections on the Bering-Chukchi platform during earlier glacial intervals.

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19. F. S. MacNeil *et al.* (*11*). The stratigraphic evidence has been summarized in more detail by D. M. Hopkins (*20*).
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Biochemical Theories of Schizophrenia

Part I of a two-part critical review of current theories and of the evidence used to support them.

Seymour S. Kety

The concept of a chemical etiology in schizophrenia is not new. The Hippocratic school attributed certain mental aberrations to changes in the composition of the blood and disturbances in the humors of the brain, but it was Thudichum (*1*), the founder of modern neurochemistry, who in 1884 expressed the concept most cogently: "Many forms of insanity are unquestionably the external manifestations of the effects upon the brain substance of poisons fermented within the body, just as mental aberrations accompanying chronic alcoholic intoxication are the accumulated effects of a relatively simple poison fermented out of the body. These poisons we shall, I have no doubt, be able to isolate after we know the normal chemistry to its uttermost detail. And then will come in their turn the crowning discoveries to which our efforts must ultimately be directed, namely, the discoveries of the antidotes to the poisons and to the fermenting causes and processes which produce them." In these few words were anticipated and encompassed most of the current chemical formulations regarding schizophrenia.

It may be of value to pause in the midst of the present era of psychochemical activity to ask how far we have advanced along the course plotted by Thudichum. Have we merely substituted "enzymes" for "ferments" and the names of specific agents for "poisons" without altering the completely theoretical nature of the concept? Or, on the other hand, are there some well-substantiated findings to support the prevalent belief that this old and stubborn disorder which has resisted all previous attempts to expose its etiology is about to yield its secrets to the biochemist?

An examination of the experience of another and older discipline may be of help in the design, interpretation, and evaluation of biochemical studies. The concepts of the pathology of schizophrenia have been well reviewed recently (*2*). As a result of findings of definite histological changes in the cerebral cortex of patients with schizophrenia which were described by Alzheimer at the beginning of the present century and confirmed by a number of others, an uncritical enthusiasm for the theory of a pathological lesion in this disease developed, and this enthusiasm penetrated the thinking of Kraepelin and Bleuler and persisted for 25 years. This was followed by a period of questioning which led to the design and execution of more critically controlled studies and, eventually, to the present consensus that a pathological lesion characteristic of schizophrenia or any of its subgroups remains to be demonstrated.

Earlier biochemical theories and findings related to schizophrenia have been reviewed by a number of authors, of whom McFarland and Goldstein (*3*), Keup (*4*), and Richter (*5*) may be mentioned (*6*). Horwitt and others (*7–9*) have pointed out some of the difficulties of crucial research in this area. It is the purpose of this review to describe the biochemical trends in schizophrenia research of the past few years, to discuss current theories, and to examine the evidence which has been used to support them.

Sources of Error

Because of the chronicity of the disease, the prolonged periods of institutionalization associated with its management, and the comparatively few objective criteria available for its diagnosis and the evaluation of its progress, schizophrenia presents to the investigator a large number of variables and sources of error which he must recognize and attempt to control before he may attribute to any of his findings a primary or characteristic significance.

Despite the phenomenological similarities which permitted the concept of schizophrenia as a fairly well defined symptom complex to emerge, there is little evidence that all of its forms have a common etiology or pathogenesis. The likelihood that one is dealing with a number of different disorders with a common symptomatology must be recognized and included in one's experimental design (*8, 10, 11*). Errors involved in sampling from heterogeneous populations may help to explain the high frequency with which findings of one group fail to be confirmed by those

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of another. Recognition that any sample of schizophrenics is probably a heterogeneous one would seem to indicate the importance of analyzing data not only for mean values but also for significant deviations of individual values from group values. The biochemical characteristics of phenylketonuria would hardly have been detected in an average value for phenylalanine levels in blood in a large group of mentally retarded patients.

Most biochemical research in schizophrenia has been carried out in patients with a long history of hospitalization in institutions where overcrowding is difficult to avoid and where hygienic standards cannot always be maintained. It is easy to imagine how chronic infections, especially of the digestive tract, might spread among such patients. The presence of amebiasis in a majority of the patients at one large institution has been reported (*12*), and one wonders how often this condition or a former infectious hepatitis has caused the various disturbances in hepatic function found in schizophrenia. Even in the absence of previous or current infection, the development of a characteristic pattern of intestinal flora in a population of schizophrenic patients living together for long periods and fed from the same kitchen is a possibility which cannot be dismissed in interpreting what appear to be deviant metabolic pathways.

In variety and quality the diet of the institutionalized schizophrenic is rarely comparable to that of the nonhospitalized normal control. Whatever homeostatic function the process of free dietary selection may serve is often lost between the rigors of the kitchen or the budget and the overriding emotional or obsessive features of the disease. In the case of the "acute" schizophrenic, the weeks and months of emotional turmoil which precede recognition and diagnosis of the disease are hardly conducive to a normal dietary intake. Kelsey, Gullock, and Kelsey (*13*) confirmed findings of certain abnormalities in thyroid function previously reported in schizophrenia and showed that in their patients these abnormalities resulted from a dietary deficiency of iodine, correctable by the introduction of iodized salt into the hospital diet. It is not surprising that a dietary vitamin deficiency has been found to explain at least two of the biochemical abnormalities recently attributed to schizophrenia (*9, 14–16*). It is more surprising that the vitamins and other dietary constituents, whose role in metabolism has become so clearly established, should so often be relegated to a position of unimportance in consideration of the intermediary metabolism of schizophrenics. Horwitt (*17*) has found signs of liver dysfunction during ingestion of a diet containing borderline levels of protein, while nonspecific vitamin therapy accompanied by a high protein and carbohydrate diet has been reported to reverse the impairment of hepatic function in schizophrenic patients (*18*).

Another incidental factor which sets the schizophrenic apart from the normal control is the long list of therapies to which he may have been exposed. Hypnotic and ataractic drugs and their metabolic products or effects produce changes which have sometimes been attributed to the disease. Less obvious is the possibility of residual electrophysiological or biochemical changes resulting from repeated electroshock or insulin coma.

Emotional stress is known to cause profound changes in man—in adrenocortical and thyroid function (*19*), in the excretion of epinephrine and norepinephrine (*20*), and in the excretion of water, electrolytes, or creatinine (*21*), to mention only a few recently reported findings. Schizophrenic illness is often characterized by marked emotional disturbance even in what is called the basal state and by frequently exaggerated anxiety in response to routine and research procedures. The disturbances in behavior and activity which mark the schizophrenic process would also be expected to cause deviations from the normal in many biochemical and metabolic measures—in volume and concentration of urine, in energy and nitrogen metabolism, in the size and function of numerous organic systems. The physiological and biochemical changes which are secondary to the psychological and behavioral state of the patient are of interest in themselves, and understanding of them contributes to total understanding of the schizophrenic process; it is important, however, not to attribute to them a primary or etiological role.

An additional source of error which must be recognized is one which is common to all of science and which it is the very purpose of scientific method, tradition, and training to minimize—the subjective bias. There are reasons why this bias should operate to a greater extent in this field than in many others. Not only is the motivation heightened by the tragedy of this problem and the social implications of findings which may contribute to its solution, but the measurements themselves, especially of the changes in mental state or behavior, are so highly subjective, and the symptoms are so variable and so responsive to nonspecific factors in the milieu, that only the most scrupulous attention to controlled design will permit the conclusion that a drug, or a diet, or a protein fraction of the blood, or an extract of the brain is capable of causing or ameliorating some of the manifestations of the disease. This is not to suggest that the results of purely chemical determinations are immune to subjective bias; the same vigilance is required there to prevent the hypothesis from contaminating the data. In a field with as many variables as this one, it is difficult to avoid the subconscious tendency to reject for good reason data which weaken a hypothesis while uncritically accepting those data which strengthen it. Carefully controlled and "double blind" experimental designs which are becoming more widely utilized in this area can help to minimize this bias.

Obvious as many of these sources of error are, it is expensive and difficult, if not impossible, to prevent some of them from affecting results obtained in this field, especially in the preliminary testing of interesting hypotheses. It is in the interpretation of these results, however, and in the formulating of conclusions, that the investigator has the opportunity, and indeed the responsibility, to recognize and evaluate his uncontrolled variables rather than to ignore them, for no one knows better than the investigator himself the possible sources of error in his particular experiment. There are enough unknowns in our guessing game with nature to make it unnecessary for us to indulge in such a sport with one another.

Schizophrenia Program of the Laboratory of Clinical Science

Since 1956, the Laboratory of Clinical Science of the National Institute of Mental Health has been developing and pursuing a program of biological research in schizophrenia designed to minimize many of the sources of error discussed above while increasing the opportunity to detect, and to correlate with psychiatric and behavioral information, true biological characteristics if they exist. One of the wards houses a group of approximately 14 clearly diagnosed schizophrenic patients, representative of as many clinical subgroups as

possible, chosen from a patient population of 14,000. In selecting these patients an attempt was made to minimize the variables of age, sex, race, and physical illness and, on the basis of careful family surveys, to maximize the likelihood of including within the group individuals representative of whatever genetic subgroups of the disease may exist (*10*). These patients are maintained for an indefinite period of time on a good diet, receiving excellent hygienic, nursing, medical, and psychiatric care. Each patient receives a careful and sophisticated psychiatric and genealogical characterization, and detailed daily records are kept on his psychiatric and behavioral status; these, it is hoped, will be of value in a more complete interpretation of biological findings. No specific therapy is employed or even found to be necessary, and drugs or dietary changes are introduced only for research purposes and for short periods of time. The other ward houses a comparable number of normal controls, who volunteer to remain for protracted periods of time on the same diet and in a reasonably similar milieu. We recognize, of course, that only a few of the variables are thus controlled and that any positive difference which emerges in this preliminary experiment between some or all of the schizophrenics and the normal population will have to be subjected to much more rigorous examination before its significance can be evaluated. Such reexamination has rarely been necessary, since our schizophrenic patients, individually or as a group, have shown little abnormality in the biological studies which have thus far been completed (*9, 14, 22–24*).

Oxygen, Carbohydrate, and Energetics

A decrease in basal metabolism was found in schizophrenia by earlier workers, although more recent work has not confirmed this (*5*), and theories attributing the disease to disturbances in the fundamental mechanisms of energy supply or conversion in the brain have enjoyed some popularity, but on the basis of extremely inadequate evidence, such as spectroscopic oximetry of the ear lobe or nail bed (*25*). Our finding of a normal rate of cerebral circulation and oxygen consumption in schizophrenic patients (*26*) was confirmed by Wilson, Schieve, and Scheinberg (*27*) and, more recently, in our laboratory by Sokoloff and his associates (*28*), who also found a normal rate of cerebral glucose consumption in this condition. These studies make it appear unlikely that the moderate decrease in these functions reported by Gordan and his associates (*29*), but only in patients with long-standing disease, is fundamental to the disease process. These studies do not, of course, rule out a highly localized change in energy metabolism somewhere in the brain, but cogent evidence for such a hypothesis has yet to be presented.

Richter (*5*) has pointed out the uncontrolled factors in earlier work which indicated that a defect in carbohydrate metabolism was characteristic of the schizophrenic disease process. The finding in schizophrenia of an abnormal glucose tolerance in conjunction with considerable other evidence of hepatic dysfunction (*30*), or evidence of an abnormally slow metabolism of lactate in the schizophrenic (*31*), do not completely exclude incidental hepatic disease or nutritional deficiencies as possible sources of error. Horwitt and his associates (*32*) were able to demonstrate and correct similar abnormalities by altering the dietary intake of the B group of vitamins.

Evidence for greater than normal anti-insulin or hyperglycemic activity in the blood or urine of a significant segment of schizophrenic patients was reported in 1942 by Meduna, Gerty, and Urse (*33*) and as recently as 1958 by Moya and his associates (*34*). Some progress has been made in concentrating or characterizing such factors in normal (*35*) urine as well as in urine from schizophrenics (*36*). Harris (*37*) has thrown some doubt on the importance of such anti-insulin mechanisms in the pathogenesis of schizophrenia, and it is hoped that further investigation may clarify the nature of the substance or substances involved and their relevance to schizophrenia.

Defects in oxidative phosphorylation have been thought to occur in this disease. Reports of alterations in the phosphorus metabolism of the erythrocyte (*38*) await further definition and independent confirmation.

Two recent reports of a more normal pattern of carbohydrate metabolism and of clinical improvement following the infusion of glutathione (*39*) in psychotic patients, some of whom were schizophrenic, are perhaps of interest. There is little verifiable evidence for a reduction in the blood glutathione index in schizophrenia (*9*); one group which has repeatedly postulated this reduction has done so on the basis of decreasingly convincing data (*16, 40*), while our laboratory has failed to find it at all (*14*), and a very recent report publishes identical figures for the schizophrenic and normal groups (*41*). Clinical and biochemical improvement in a variety of psychoses following glutathione infusion, even if it is accepted without the necessary controls, suggests at best that glutathione is of secondary and nonspecific import.

It is difficult for some to believe that a generalized defect in energy metabolism—a process so fundamental to every cell in the body—could be responsible for the highly specialized features of schizophrenia. On the other hand, a moderate lack of oxygen, an essential requirement of practically every tissue, produces highly selective manifestations involving especially the higher mental functions and as suggestive of schizophrenia as manifestations produced by many of the more popular hallucinogens. It may not, therefore, be completely appropriate that, in a search for biochemical factors etiologically related to schizophrenic psychoses, the center of interest today appears to have shifted to other, more specialized aspects of metabolism.

Amino Acids and Amines

The well-controlled studies of the Gjessings (*42*) on nitrogen metabolism in periodic catatonia arouse considerable interest in that they suggest the possibility of a relationship between intermediary protein metabolism and schizophrenia, although earlier workers had postulated defects in amino acid metabolism in this disease (*43*). The hallucinogenic properties of some compounds related directly or indirectly to biological amines reawakened this interest, and the techniques of paper chromatography offered new and almost unlimited opportunity for studying the subject.

The first group to report chromatographic studies of the urine of schizophrenic and control groups found certain differences in the amino acid pattern and, in addition, the presence of certain unidentified imidazoles in the urine of schizophrenics (*44*). Although a normal group of comparable age was used for comparison, there is no indication of the extent to which dietary and other variables were controlled, and the authors were properly cautious in their conclusions. In a more extensive series of studies, another group has re-

ported a significantly higher than normal concentration of aromatic compounds in the urine of schizophrenic patients (*45*) and has suggested that there are certain qualitative differences in the excretion of such compounds (*46*). Others have reported the abnormal presence of unidentified amines (*47*) or indoles (*48*), and one group has reported the absence of a normally occurring indole (*49*) in the urine of schizophrenic patients. In some of these studies there appears to have been no control relative to possible drug therapy or to volume or concentration of urine, and in few of them was there control of diet. There are numerous mechanisms whereby vitamin deficiencies may cause substantial changes in the complex patterns of the intermediary metabolism of amino acids. In addition, the fact that a large number of aromatic compounds in the urine have recently been shown to be of dietary origin (*50*) suggests the need for considerably more caution than has usually been employed in drawing conclusions with regard to this variable. Another point which has not been emphasized sufficiently is that chromatographic procedures which make possible the simultaneous determination of scores of substances, many of them unknown, require statistical analyses somewhat different from those which were developed for the testing of single, well-defined hypotheses. It is merely a restatement of statistical theory to point out that in a determination of 100 different compounds carried out simultaneously in two samples of the *same* population, five would be expected to show a difference significant at the 0.05 level! It is interesting to note that a more recent study was able to demonstrate considerably fewer differences between the urines of normal and schizophrenic populations and drew very limited and guarded conclusions (*51*). In our own laboratory, Mann and LaBrosse (*24*) undertook a search for urinary phenolic acids, in terms of quantity excreted in a standard time interval rather than in terms of concentration, which disclosed significantly higher levels of four compounds in the urine of schizophrenics than in that of the normal test subjects. These compounds were found to be known metabolites of substances in coffee, and their presence in the urine was, in fact, better correlated with the ingestion of this beverage than with schizophrenia.

The hypothesis that a disordered amino acid metabolism is a fundamental component of some forms of schizophrenia remains an attractive though fairly general one, chromatography as a means of searching for supporting evidence is convenient and valuable, and preliminary indications of differences are certainly provocative. Proof that any of these differences are characteristic of even a segment of the disease rather than artifactual or incidental has not yet been obtained.

The Epinephrine Hypothesis

The theory which relates the pathogenesis of schizophrenia to faulty metabolism of epinephrine (*52–54*) is imaginative, ingenious, and plausible. It postulates that the symptoms of this disease are caused by the action of abnormal, hallucinogenic derivatives of epinephrine, presumably adrenochrome or adrenolutin. By including the concept of an enzymatic, possibly genetic, defect with another factor, epinephrine release, which may be activated by stressful life situations (*22*), it encompasses the evidence for sociological as well as constitutional factors in the etiology of the schizophrenias.

The possibility that some of the oxidation products of epinephrine are psychotomimetic received support from anecdotal reports of psychological disturbances associated with the therapeutic use of the compound, especially when it was discolored (*52*), and from some early experiments in which the administration of adrenochrome or adrenolutin in appreciable dosage was followed by certain unusual mental manifestations (*54*). A number of investigators failed to demonstrate any hallucinogenic properties in adrenochrome (*55*), and the original authors were not always able to confirm their earlier results.

Meanwhile, reports were emerging from the group at Tulane University, suggesting a gross disturbance in epinephrine metabolism in schizophrenic patients. Five years previously, Holmberg and Laurell (*56*) had demonstrated a more rapid oxidation of epinephrine in vitro in the presence of pregnancy serum than with serum from the umbilical cord and had suggested that this was due to higher concentrations of ceruloplasmin in the former. There had also been a few reports of an increase in levels of this protein in the blood of schizophrenics. Leach and Heath (*57*) reported a striking acceleration in the in vitro oxidation of epinephrine in the presence of plasma from schizophrenic patients as compared with that from normal subjects and shortly thereafter implicated ceruloplasmin or some variant of ceruloplasmin as the oxidizing substance (*58*). Hoffer and Kenyon (*59*) promptly reported evidence that the substance formed from epinephrine by blood serum in vitro was adrenolutin and pointed out how this strengthened the epinephrine hypothesis.

All of the evidence does not, however, support the epinephrine theory. In the past few years the major metabolites of epinephrine have been identified: 3-methoxy-4-hydroxymandelic acid, by Armstrong and his associates (*60*), and its precursor, metanephrine, by Axelrod and his coworkers of this laboratory (*61*), where, in addition, the principal pathways of epinephrine metabolism in animals (*62*) and man (*63*) have been demonstrated. The metabolites of C^{14}-labeled epinephrine in the urine of schizophrenic patients (*64*) and in normal man (*65*) have been studied independently by others. No evidence has been found for the oxidation of epinephrine via adrenochrome and adrenolutin in any of these populations. Although it has been reported that there are appreciable amounts of adrenochrome in the blood of normal subjects and that these amounts increase considerably following administration of lysergic acid diethylamide (*66*), Szara, Axelrod, and Perlin, using techniques of high sensitivity, have been unable to detect adrenochrome in the blood of normal test subjects or in that of acute or chronic schizophrenic patients (*22*). In a recent ingenious study of the rate of destruction of epinephrine in vivo, no difference between normal subjects and schizophrenic patients was found in this regard (*67*). Finally, it has been shown, by McDonald (*9*) in our laboratory and by members of the Tulane group themselves (*16*), that the low level of ascorbic acid in the blood is an important and uncontrolled variable in the rapid in vitro oxidation of epinephrine by plasma from schizophrenic patients. The fact that McDonald has been able to produce wide fluctuations in the epinephrine oxidation phenomenon, from normal to highly abnormal rates, in both normal subjects and schizophrenics merely by altering the level of ascorbic acid in the blood by dietary means, and that this has had no effect on the mental processes of either group, is quite convincing evidence of the dietary and secondary nature of the phenomenon.

It should be pointed out that none of this negative evidence invalidates the

theory that some abnormal product of epinephrine metabolism, existing somewhere in the body, produces the major symptoms of schizophrenia; it does, however, considerably weaken the evidence which has been used to support the theory. In addition, there is the bothersome observation of numerous workers (*68*) that the administration of epinephrine to schizophrenics, which, according to the theory, should aggravate the psychotic symptoms, is not accompanied by appreciably greater mental disturbance than occurs in normal subjects.

Quite recently a new report on inconstant psychotomimetic effects of epinephrine oxidation products in a small number of subjects has appeared (*69*), with evidence suggesting that the psychotoxic substance is neither adrenochrome nor adrenolutin, that it is active in microgram quantities, and that it is highly labile. This report, like the previous ones which described the psychotomimetic effects of epinephrine products, is highly subjective and incompletely controlled. Even if these conclusions are accepted, the relevance of such hallucinogens to, or their presence in, schizophrenia remains to be demonstrated.

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News of Science

Nine-to-Eight Vote Sends Strauss Nomination to Senate

By a vote of 9 to 8, the Senate Interstate and Foreign Commerce Committee, on 19 May, sent the nomination of Lewis L. Strauss as secretary of commerce to the Senate floor. Thus, Strauss, who has been acting secretary since his recess appointment on 13 November, has weathered one of the longest and most bitter confirmation fights since the Coolidge administration. But the fight is not over for Strauss, who made many enemies during his 5-year tenure as chairman of the Atomic Energy Commission. A similar but less severe challenge to his confirmation is expected to develop in the full Senate. Nevertheless, the critical test has been passed.

Three Democratic Votes Decisive

Had the 11 Democrats on the Senate committee voted in a block, as the Republican members did, the nomination would have been killed. However, Pastore (D-R.I.), Thurmond (D-S.C.), and Lausche (D-Ohio), acting in accord with previously announced intentions, cast the three votes which, with the Republicans' six decided the issue for Strauss. The vote ended the hearings, which had begun more than 2 months earlier when committee chairman Wayne Magnuson (D-Wash.), who voted against the nomination, warned Strauss that there was a long and hard fight ahead.

Heavy Opposition

Opposition to the nomination came from several sources. Senator Clinton P. Anderson (D-N.M.), who had been chairman of the Joint Atomic Energy Committee of Congress during much of Strauss' tenure as AEC chairman, led the attack by concentrating on the conduct of the nominee during that period. He suggested that Strauss had "sought to create myths about his accomplishments," and that he had "made deliberate efforts to avoid keeping the joint committee . . . informed." Anderson was joined in this criticism by members of the Federation of American Scientists, represented by their incoming chairman, David R. Inglis. A former chairman of the group, David L. Hill, continued the attack with more than 25 pages of prepared testimony. Another opponent was Senator Kefauver, who cited certain of Strauss' actions in regard to the Dixon-Yates controversy.

The criticism of the witnesses was directed as much at Strauss' personality as at his actions as AEC chairman. Hill, in his testimony, suggested that the nominee had demonstrated a number of character defects during his AEC chairmanship that made him a bad risk in his new position. He suggested that Strauss has a "facility for repeated misrepresentation," that he had been guilty of "arrogant usurpation of authority and responsibility," and that his "personal vindictiveness toward those who have disagreed with his official positions" had moved him to misuse the personnel security system of the government.

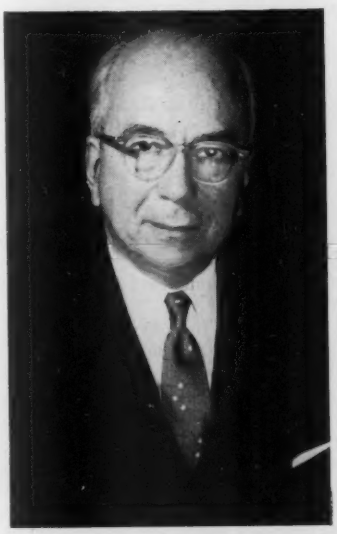
Supporters Cite Contributions

Speaking for Strauss before the committee were a number of scientists, administrators, and political figures. Edward Teller, the nuclear physicist, said that Strauss had demonstrated a "long-standing, warm, and effective support of science." Other witnesses, who in the main simply answered questions put to them by committee members, agreed that Strauss was a friend of science. John W. Bricker, former senator from Ohio, said that during his service on the Joint Atomic Energy Committee he had seen no evidence that Strauss had withheld information from the committee. Detlev W. Bronk, president of the National Academy of Sciences, cited five occasions when he had had contact with Strauss in past years. Each, he said, was characterized by complete cooperation on Strauss' part. When asked if he had noticed the arrogance or dogmatism that the hostile witnesses had mentioned, Bronk said he had not and added that he imagined that during his own career as an administrator a number of his subordinates had found him dogmatic and difficult, especially when he had had to refuse a request for more funds or for another secretary. Strauss' influence on the decision to make the fusion bomb, also cited by witnesses in his behalf, particularly impressed the committee because of its significance for the national defense.

During the course of the long hearings President Eisenhower spoke out a number of times in favor of Strauss. "I think," the President declared at a news conference, "that Secretary Strauss is one of the finest public servants I have known." ". . . I have never heard one single word against his character, against his honesty and his ability and therefore I am really puzzled as to why this delay should occur."

Some Reasons for Delay

A number of factors seemed to lie behind the long struggle over Strauss' nomination. Perhaps foremost, according to some observers, is a singular confluence of events. There is, as the hostile witnesses made clear, a solid body of opinion against the nominee. Apart from the hearings, this was demonstrated by the resistance that developed when it was learned that he was scheduled to address the American Physical Society on 1 May. Many members of the society formed a "Last Strauss Committee" to prevent his appearance. This action, although unsuccessful, indicated that the Federation of American Scientists was not alone in its reaction. This body of opinion of itself would have made the confirmation hearings difficult for Strauss. Another factor, however, came into play against him. This was the unusual predisposition of the Democratic Congress to question the qualifications of the President's various appointees to



Lewis L. Strauss

office. In past years these confirmation hearings were usually matters of routine. Recently, however, Congress has been nothing less than militant in its attitude toward Eisenhower's nominees for various posts of government. If the Senate does not cause such a furor that the appointee resigns, as Clare Booth Luce did, it rebukes the President for delay, as it did by rushing through its confirmation of Herter as Secretary of State in a matter of hours. This new exercise of power on the part of the Congress compounded Strauss' trials. The question for the immediate future is whether this same combination of positive opposition and a rampant Congress will work against him when the full Senate votes.

Britain Launches Space Program

Britain has announced the immediate start of a space research program. In an address before the House of Commons in mid-May, Prime Minister Macmillan described the initial plans. He explained that there are two problems to be considered: the nature and design of the instruments to be carried into space and the means by which the containers for these instruments are to be launched. He went on to say that, with regard to the first, a program has been approved and work will begin at once. With regard to the second, he commented that "there may well be scope for joint action with the United States . . . or with other countries."

He then reported that a team of specialists, headed by H. S. W. Massey, professor of physics at University College, London, will visit Washington toward the middle of June to discuss possible Anglo-American cooperation. Simultaneously, consultations are being held with the Commonwealth countries. While these talks are going on, however, studies are under way on means of adapting British military rockets to launch satellites. Macmillan said: "This will put us in a position, should we decide to do so, to make an all-British effort." The instrument program will be supervised by the British National Committee on Space Research, which has been set up by the Royal Society under the chairmanship of Massey.

In discussing the cost of the program, the Prime Minister commented: "I cannot give any figure of the cost of using a British rocket, should it be decided to do so. What we are doing now is to spend substantial, but modest, sums—more in hundreds of thousands of pounds than in millions—first, for the design of the instruments, and, secondly, to make the necessary designs for modification of the military rocket. . . ."

A Labour member of the House asked the Prime Minister if he was "satisfied that there is an intrinsic value in this work from the scientific point of view, rather than just an attempt to keep up with the Joneses." Macmillan replied: "I am not, by nature or by education, very favourably inclined to swallow all that the scientists tell me, because I, alas, do not understand it [laughter]. But I am impressed by the universal opinion of those very distinguished people whom we have consulted, and I feel that certainly upon the scientific instrument work it is clear that Britain should play her part in this advancing scientific effort [Ministerial cheers]."

Space a Public Issue

The enthusiastic response to these remarks reflects the degree to which a space program has become a public issue in Britain. The Government has long been under pressure from the Labour Party opposition and from a growing number of British scientists to enter the field of space, an area of scientific inquiry that has until now been monopolized by the United States and the Soviet Union. British space research has been postponed primarily because of the great cost involved. Those who have objected to the launching of a space program have pointed out that the results of such research were already available from the United States and, to a lesser extent, from the U.S.S.R.

However, a number of British scientists interested in space have taken jobs in the United States. This, and considerations of national pride, have disturbed some members of Parliament. In replying to a question in the House of Commons on 20 April, according to the 2 May issue of *Nature,* the Minister of Supply acknowledged that the danger of losing Britain's "youngest and ablest scientists to the United States in the absence of occasional opportunities for such research, even if it involved using equipment originally designed for a specific military purpose, was an important consideration."

British scientists have also been stirred by feelings of concern for the nation's prestige, and Sir Harold Spencer Jones, former Astronomer Royal, expressed the view of many when he wrote as follows in a feature article in the *Sunday Times* of 5 April:

"It has been suggested that our scientists might plan experiments and design and construct the instrumental equipment for research with satellites and space-probes and ask for space in vehicles launched by another country. That, however, would not be appropriate to the prestige and standing of Britain in the world today.

"As a matter of national prestige, and because Britain's future depends upon keeping abreast of new developments, I am of the opinion that Britain cannot afford to stay outside this new field, and that she should embark upon a program of space research."

Scope of Britain's Space Plans

A special dispatch from London to the *New York Times* on 23 April indicated the direction of British space research when it quoted high government officials as saying that Britain's objective in any earth-satellite program would be basic research. This would be in contrast to what Britain regards as the emphasis put on engineering by the United States. Another distinction, the *Times* said, is the preoccupation in the United States with exploring space for the ultimate purpose of space travel, for Britain is more interested in the terrestrial usefulness of space exploration.

An idea of the probable time-scale for the British space research program and of the issues that remain to be decided was provided by a press conference that was held by Lord Hailsham, Lord President of the Advisory Council on Scientific Policy, immediately after the Prime Minister's announcement to Parliament. Conference participants, in addition to Massey, included other principal figures in British space administration: Aubrey Jones, Minister of Supply; Sir Owen Wansbrough-Jones, chief scientist of the Ministry of Supply; and Sir Edward Bullard, chairman of a steering group appointed by Hailsham.

Massey indicated that on his United States trip, in addition to seeking details about U.S. earth satellites, he will discuss an American offer to launch another country's satellite, perhaps one of approximately 150 pounds. A British vehicle of about 1000 pounds was mentioned as a possibility at the conference. The U.S. offer was made to COSPAR, the international committee for space research that was established by the International Council of Scientific Unions.

The *New York Times,* in commenting on the press conference, indicated that the newsmen's questions reflected what appeared to be disappointment that the first British satellite might have to be launched by means of a U.S. rocket. One questioner was reported to have asked Massey if he would say "on the record" whether or not he was satisfied with a satellite launching in which the rocket used was not of British manufacture. Massey was quoted as having replied: "I will go on record as saying that I am not at all dissatisfied with this project."

Sir Edward Bullard discussed the space program time-schedule with the

correspondents, saying, according to the London *Times* for 13 May, that the design of instruments would take not less than a year, but that Britain would be "doing badly" if it took many years.

The London paper reported that Lord Hailsham, in describing the scope of the program, emphasized that the Advisory Council on Scientific Policy had advised against moon launchings. He said, further, that no monkeys or other animals would be sent up in the British satellite.

Contrast with U.S. Space Budget

Lord Hailsham is also reported to have emphasized, like Macmillan, that the expenditure for the development of instruments and for the design studies on launching vehicles would be some hundreds of thousands of pounds. This is in striking contrast to the budget for this country's National Aeronautics and Space Administration that was recently approved by the House of Representatives. On 20 May, the House passed H.R. 7007, which authorizes appropriations to NASA for fiscal year 1960 in the amount of $480,550,000—$94,430,000 for salaries and expenses, $333,070,000 for research and development, and $53,050,000 for construction and equipment.

In his *Sunday Times* article, Sir Harold Spencer Jones indicated how he feels the British Government should view the cost problem.

"The cost of scientific research has increased enormously since the 'string and sealing-wax' days. The large optical telescopes in use today, the much larger radio-telescopes of the radio-astronomers, and the particle-accelerating machines of the nuclear physicist, are expensive tools. But their cost is small compared with even a modest programme of space research. It is already apparent, however, that scientific research *must* extend into space for progress in knowledge in various directions to be made. Should Britain sit back and leave these new, important and exciting fields of investigation to other countries?"

Future of Foreign Scientist Program Undecided

The future of the Visiting Research Scientist Program, which allows foreign researchers to work in the United States, continues to remain in doubt pending some indication of continued support from its source of funds, the International Cooperation Administration. The post of director at ICA has been vacant since last February when James H. Smith, Jr., an active supporter of the program, resigned. A new director, James F. Riddleberger, former ambassador to Yugoslavia, was appointed, but he has yet to assume the post. Meanwhile, the National Academy of Sciences, which administers the program for ICA, continues, on the basis of already authorized funds, to place young foreign scientists in university and governmental laboratories throughout the country. To date, 65 foreign researchers have arrived in this country under recently expanded provisions of the program. During an earlier phase, some 225 scientists, mostly from Western Europe, studied here.

Program Expanded

The program was originally conceived in 1953. At that time it was restricted to the 14 European countries which were members of the Organization for European Economic Cooperation. In May 1958, however, after a request by the International Cooperation Administration, the program was expanded to include many non-European countries. As a result, some 44 countries now send research workers to the United States. Of this total, 23 countries, including Indonesia, Iran, and Thailand, are represented by the 65 young scientists now at work at universities throughout the country. The visiting researchers, drawn from universities, governmental scientific facilities, and, in a few cases, industrial laboratories in their respective countries, are doing research on problems in their various fields. Under the program another 85 researchers will arrive in this country after the end of the academic year, for periods of study ranging from 1 to 2 years.

Most Stay Two Years

Although as the program was originally set up, each grant was for a period of 1 year, most of the grantees avail themselves of the 1-year extension that is now offered. They are encouraged to do so by the academy, which feels that 2 years' time is needed for any significant research program. At the end of the first year, however, the academy does make an evaluation of the grantees' work. A statement of progress is requested from each visitor. In addition, the grantee's adviser, usually an American scientist at the same laboratory, is asked to comment on his foreign colleague's work. To date, no grants have been terminated because of inadequate work.

Advisory Committees Set Up

The National Academy of Sciences has set up advisory committees in the many foreign countries from which the visiting researchers are drawn. These groups, composed of academicians and administrators, recommend candidates to the academy. These candidates are almost invariably accepted by the academy, which then corresponds with the individual to determine his field of interest and the particular research problem which he wants to undertake. With this information, the program staff members, headed by Walter F. Colby, survey the university and governmental laboratories in this country to determine where work is being done in the candidate's field. After consultation with the administrators of these laboratories, the candidate is then placed in one of them. To date, according to Academy officials, no placements have been refused, and correspondence from both candidates and advisers indicates that the personal relationships established in this way have been of great value.

When the NAS-ICA program was expanded in 1958, the problem arose of finding ways to maintain the standards that had been established during the period when Western Europe was the source of candidates. Many of the non-European countries did not have "sister academies" with which our National Academy could work. The problem was solved by setting up committees which were staffed by men from the universities of the countries concerned.

Program Works Well

Correspondence from grantees and advisers seems to support the view of academy officials that the Visiting Research Scientist Program has been working very well since its inception in 1954. The aims of the program—strengthening scientific activity in the free world, building intimate relationships between American scientists and the leading scientists of the future in the many countries participating, and increasing cooperation between foreign scientific organizations and the U.S. Academy—are being accomplished. There is, however, concern about the future of the program. The great danger, according to academy officials, is that the nominating committees, which were set up all over the free world, will begin to disband, with no work to be done.

The following excerpts from a letter addressed to President Eisenhower by one of the grantees tell of his response to the Visiting Research Scientist Program: "I am a Portuguese biologist who has been in the United States for the last two years. . . . I would like to express to the people of the United States in your person my thanks for the excellent opportunity of working in this country, a stay that has left wonderful and unforgettable memories. I benefited from my contact with American scientists and I have enjoyed marvelous hospitality. My wife and I hope that your country will be able to enjoy forever in peace the prosperity that it built with its own hands."

Increased Outlay for Atom Smashers Asked

Following are excerpts from a report released 16 May entitled "A Proposed Federal Program in Support of High Energy Accelerator Physics" which was prepared by a special panel appointed by the President's Science Advisory Committee and the General Advisory Committee to the Atomic Energy Commission.

There is now need to review the high energy accelerator program and needs at the Presidential level. This stems from: (a) the extraordinarily high cost of the construction and utilization of high energy accelerators; (b) the fact that all support in this scientific area comes from the Federal Government; (c) the interest of a number of Government agencies in the science and technology associated with both the construction and the experimental results; and (d) the desire to have an orderly national program taking full account of the activities abroad.

A number of groups within the Federal Government have studied this problem. The most detailed examinations have been made by the Advisory Panel on High Energy Accelerators of the National Science Foundation. Other advisory groups which have also been concerned with this general area are the President's Science Advisory Committee, the General Advisory Committee to the Atomic Energy Commission, and the Defense Science Board of the Department of Defense. There is general agreement on the recommendations contained herein among the several groups listed above.

The United States has 15 high energy accelerators in operation with energies above 200 MEV [million electron volts]; four of these have energies in excess of 1 BEV [billion electron volts] and are capable of producing "strange particles." The highest energy particles now available are 6.2 BEV protons and 1.2 BEV electrons. Four additional accelerators are under construction by the Atomic Energy Commission; a 6 BEV electron synchrotron at Cambridge, Massachusetts (Harvard–MIT); a 25–30 BEV proton synchrotron at the Brookhaven National Laboratory; a 12.5 BEV proton synchrotron at the Argonne National Laboratory; and a 3 BEV proton synchrotron at Princeton University that will greatly increase the intensity available at that energy. The Argonne and Brookhaven accelerators will be capable of producing all known types of particles.

Needs Reviewed

The Committee has carefully reviewed the present high energy accelerator program in the light of the above factors and finds that the future United States requirements fall into four major categories.

(i) It is necessary to continue and to expand the support of presently operating accelerators to assure maximum exploitation. This requires continuous updating of facilities, expansion of research space, and the support of major efforts aimed at the augmentation of existing techniques for beam analysis, particle detection and data reduction and analysis.

(ii) It is necesssary that the accelerators now under construction be finished without undue delay and that adequate funds be provided to equip and operate them. It is necessary to give particular attention to providing early support to plans for initial experimental facilities in order that these facilities be efficient, flexible, and available once an accelerator is operating.

It is clear that the Federal Government is committed to provide adequate support to those accelerators which are now in operation or under construction in order to fully exploit the capabilities of the instruments. Thus, regardless of decisions which may be made with respect to the construction of additional accelerators, high energy accelerator physics can be expected to be costing the Government about $75–$80 million annually by 1963. This figure must be considered as a base cost upon which any future forward steps must be built. The projected costs [shown in the accompanying table] have been jointly developed by the Atomic Energy Commission, Department of Defense and National Science Foundation and reflect the present degree of diversity of support.

(iii) There is a clear need for the construction and operation of additional accelerators both to increase the energy and intensity parameters and to increase the U.S. capacity for experimentation in this field.

There does not now appear to be a clear need for extension of the energy parameter for *protons* beyond the 30 BEV now in sight at the Brookhaven National Laboratory and CERN [the European center in Geneva, Switzerland]. There is an immediate need for a moderately high intensity *electron* accelerator in the energy region of 10–15 BEV. There is also a need for a high intensity *proton* accelerator at an energy of 8 BEV or above. Accelerators to meet these needs will cost approximately $15–$20 million each per year to build and operate. Thus, these two needs can be expected to increase the costs of high energy accelerator physics from $75–$80 million to about $120 million per year in the course of the next five years.

The faculties and students of the nation's universities have increased access to high energy accelerators. The additional accelerators need not necessarily be unique or extreme in their energy or intensity characteristics in order to fully justify their construction at a site where they may exploit the unique capabilities of a single university or group of institutions. It is our best judgment that by fiscal year 1963 an additional $15 million per year will be required to meet these needs, thus raising the total cost of high energy accelerator physics to between $120 and $135 million per year by 1963.

Annual high-energy physics support (in thousands of dollars) by various government agencies based on existing or authorized accelerators.

Fiscal year	Atomic energy commission		Office of Naval Research	Air Force Office of Scientific Research	National Science Foundation	Total
	Operation	Construction				
1946			3,900			3,900
1947		500	4,000			4,500
1948	3,400	600	2,400			6,400
1949	4,800	1,600	2,200			8,600
1950	3,400	7,500	1,600			12,500
1951	5,900	4,100	3,300			13,300
1952	6,300	1,700	1,600			9,600
1953	7,600	2,300	2,400			12,300
1954	7,400	1,900	1,800	270	80	11,400
1955	8,300	1,600	1,500	320	280	12,000
1956	10,200	3,200	1,600	610	220	15,800
1957	16,000	7,000	2,000	930	180	26,100
1958	19,100	12,900	3,300	1,000	210	36,500
1959*	27,700	26,300	3,300	865	400	58,600
1960*	36,600	20,500	3,600	950	700	62,400
1961*	45,900	19,000	4,000	1,150	1,000	71,100
1962*	53,700	18,800	4,400	1,250	1,500	79,700
1963*	60,500	9,000	4,800	1,550	2,000	77,900

* Estimated.

(iv) Research and exploratory development of new accelerator concepts must be strongly supported without prejudice to a later determination of need for full-scale construction. In addition, in order to make optimum use of the accelerators, strong support will be required for advancing the techniques of particle detection, data reduction, and data analysis.

Federal Responsibility Stressed

The basic importance of research in the field of high energy physics and its high cost, well beyond private resources, requires the Federal Government to continue to expand its support of this field consistent with valid scientific needs and the availability of qualified research personnel. Consequently, government planning must be based on the need for an increasing level of support from some $59 million in fiscal year 1959 to approximately $135 million in fiscal year 1963, in accordance with the needs outlined above.

It is important that the Atomic Energy Commission, the National Science Foundation and the Department of Defense each support research in high energy physics because of their separate responsibilities for the support of basic research, because of the fundamental nature and significance of high energy physics and the corresponding need for each of these agencies to keep in direct and intimate contact with the scientists in this field and their research. Accordingly, the construction and operation of future high energy accelerators should not be considered the responsibility of any single Federal agency.

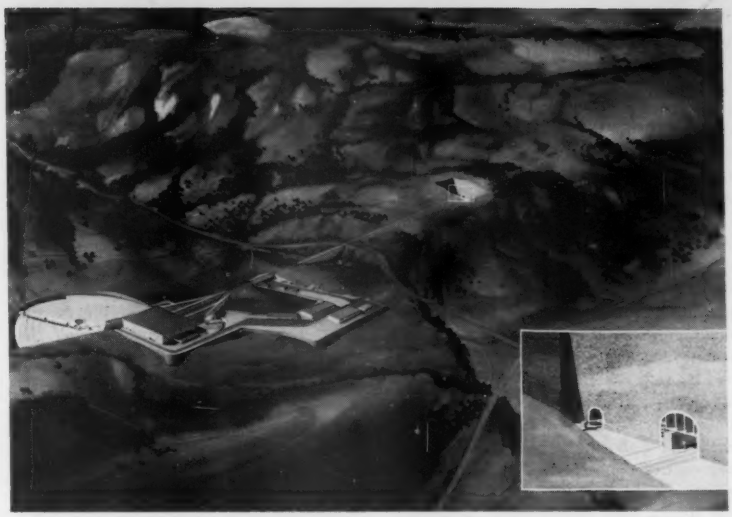
The Atomic Energy Commission, Department of Defense and National Science Foundation should each maintain strong interests and contacts in the field of high energy accelerator physics. This can be achieved only through direct financial responsibility and participation in the construction of high energy accelerators. The budgeting for the total cost of construction and operation of a particular accelerator should be the responsibility of a single Federal agency, as sole agent on behalf of all, supplemented by appropriate coordination with the other agencies active in this field.

These large particle accelerators constitute a national asset and should be made available to competent scientists elsewhere in this country and abroad to the fullest extent practicable. The support of any given accelerator project by a particular Federal agency should not be construed to prevent or limit the financial support of outside groups using the accelerator by other agencies, public or private.

The parallel interest of several Federal agencies in the support of high energy physics and the impact of this support on national budget planning and programming require a coordinating mechanism to assure effective planning and review at the national level. An interdepartmental council on high energy accelerators should be established to assure coordination of budget and technical planning. The membership of the council should consist of policy level representatives from the Atomic Energy Commission, Department of Defense and National Science Foundation. Technical assistance to the council should be provided by the scientific staff of the three agencies (AEC, DOD and NSF) directly concerned with the administration of high energy physics research programs. The council should be responsible for continuing reformulation of national policies on high energy accelerator physics and the implementation of this policy. This should include the review and coordination of agency programs and plans in the field of high energy accelerator physics and the review of agency proposals for new accelerators.

There should be a review of contracting procedures by the Atomic Energy Commission, Department of Defense and National Science Foundation to assure that such procedures properly support scientific undertakings of this magnitude and character. Present procedures should be revised where necessary so that agencies can provide funds in the contract, for a period of one to three years in advance, for the support of research operations connected with high energy accelerators.

The world-wide scientific significance of research in high energy physics, the extensive, high quality of scientific activity abroad in this field, and the limited number and costliness of high energy accelerators present a unique opportunity for a high degree of international collaboration and cooperation in the planning for and design of future accelerators and in the increased use of facilities. As a first step in the direction of international collaboration looking toward the development of new high energy accelerators, representative scientific groups from other countries, including the U.S.S.R., should be encouraged to meet with us in order to lay plans for cooperative research on new accelerator concepts. The National Academy of Sciences should be requested to advise on the best means for accomplishing this objective.



Two-mile linear accelerator at Stanford University in California would have an initial energy of at least 10 BEV.

Stanford Proposal Accepted

Consistent with the needs and guidelines outlined above, the following comments apply to the three major proposals before the Federal Government.

The Stanford proposal for an electron linear accelerator adequately meets the requirement discussed above of a research need for a new electron accelerator and its technical feasibility has been adequately demonstrated. It should be supported fully with the ultimate objective as described in the proposal and with an initial energy of at least 10 BEV. It is desirable that this accelerator project be initiated in fiscal year 1959 in order to avoid an undue delay in high energy research. Because of its dependence on advanced microwave technology, this proposal should be of particular relevance to the interests of the Department of Defense.

Although the technical feasibility

and research utility of the specific accelerator recently proposed by Midwestern Universities Research Association (MURA) have not been established, many of the important new accelerator concepts of recent years have come from the ideas and work of the MURA group. Continued progress in these developments is strongly dependent on the continuation and intensification of the MURA program. The group should be supported on a continuing basis with the funds and facilities necessary for its participating intensively in the development, construction and operation of high energy accelerators.

The research need for a high energy accelerator at the Oak Ridge National Laboratory should be further explored with the Laboratory and the southern universities concerned. The Oak Ridge group should be supported in continuing design and development activities. The technical feasibility of the accelerator proposed by Oak Ridge has not been established.

Panel Members

Jesse W. Beams, chairman, department of physics, University of Virginia

Hans A. Bethe, professor of physics, Cornell University

Leland J. Haworth, director, Brookhaven National Laboratory

Edwin M. McMillan, director, Lawrence Radiation Laboratory, University of California

Emanuel R. Piore, *chairman,* director of research, International Business Machines Corporation

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Training Center for U.N. Fellows

A new type of regional training center for United Nations fellows, with headquarters at the University of British Columbia in Vancouver, B.C., will enable trainees from underdeveloped countries to study activities in fields such as hydroelectric power, water development, geology, mining, forestry, land management, cooperatives, credit unions, social welfare, and public administration. In contrast to training centers that provide formal lectures and group field trips, the Vancouver center will draw up individual training plans designed to fill the specific needs of each fellow.

The rivers, forests, cities, and industries of western Canada and northwestern United States will serve as a laboratory. A trainee selected under the U.N. technical assistance program may enroll for classroom instruction, if appropriate, or he may carry out guided studies under faculty supervision. In addition, he will be given opportunity for first-hand observation in his specialty in a field agency or governmental laboratory. Western Canada and the northwestern United States were chosen because in the past 50 years these areas have experienced unusual expansion in population and unusually rapid economic development.

Under a three-way agreement, the United Nations will supply fellowships for the trainees and will provide a director and an administrative officer. The University of British Columbia will provide instruction and guidance for the fellows, as well as office space for the center. The Canadian Government, subject to parliamentary approval, has offered a special annual grant of $10,000 to the U.N. for operation of the center, to be made in each of three consecutive fiscal years, beginning in 1959–60. In addition, the United States Government has made the facilities of its agencies in the northwestern states available to the trainees.

The director of the center will be Albert Lepawsky of the department of political science, University of California, Berkeley, who was a member of the U.N. technical assistance survey mission to Bolivia in 1950. Fellowships for the center will be provided under the present technical assistance program of the United Nations and related agencies.

Federal Court Asked to Halt Atomic Tests

The Federal Court of Appeals, Washington, D.C., was asked in an action filed last month to order the United States to halt nuclear tests. The appeal was made by a group of 39 people, including scientists, churchmen, Japanese fishermen, and residents of the Marshall Islands. Among the plaintiffs were Linus Pauling, Nobel Prize winner in chemistry and professor at California Institute of Technology, and Bertrand Russell, British mathematician and philosopher.

The group asked the Court of Appeals to reverse a ruling that was handed down by District Judge Richmond B. Keech last July. At that time he dismissed two similar suits, saying the complaints had failed to show a controversy within the court's jurisdiction. He also held that none of the 39 plaintiffs had standing to sue. The appeal will probably be heard by the court next fall.

Edison Awards

The Thomas Alva Edison Foundation awarded special citations to the following at a luncheon in New York on 20 May as a part of the foundation's continuing program to improve the presentation of science to youth.

The Scientific American, Girard Piel, publisher, in recognition of distinguished educational service to the nation by advancing the understanding of science through accurate, informative, and vivid reporting of the latest scientific developments.

Union County Regional High School District No. 1, Springfield, N.Y., in recognition of distinguished educational service to the nation for special excellence in developing more effective teaching of science.

A Parent's Guide to Children's Reading, by Nancy Larrick (Doubleday and Pocket Books), in recognition of distinguished educational service . . . in the development of wholesome reading by young people.

Gilberton Company, Inc., for publishing *The Illustrated Story of Space*, one of the series "The World Around Us," as "the best science comic book."

AEC Power Program Approved by Joint Congressional Committee

The legislative subcommittee of the Joint Atomic Energy Committee of the Congress has approved, almost without change, the atomic power program put forth early this year by John A. McCone, chairman of the Atomic Energy Commission. This action confirms the growing belief that a new harmony has developed between the committee and the commission. In past years, when Lewis L. Strauss was chairman, this relationship had been very stormy.

The commission had requested $49.5 million for the construction of five prototype atomic power plants, either by the Government or by industry with government aid. Only three new projects were added to the total program, which, when it was first submitted, was characterized as "wholly inadequate." These new projects are a reactor of advanced design, to be built in Puerto Rico; a prototype plant of 30,000- to 75,000-kilowatt capacity; and another plant to be built for a rural cooperative or public power company by the commission.

Inter-American Nuclear Energy Commission to Hold First Meeting

The Organization of American States, Pan American Union, Washington, D.C., is establishing an Inter-American Nuclear Energy Commission to plan for the peaceful application of nuclear energy in the Western Hemisphere. The statutes for the commission were approved by the council of the OAS on 22 April. The new organization will hold its first meeting at the Pan American Union, probably in October.

The commission is being formed to:

1) Act as a consultative body in technical, economic, and administrative problems in nuclear science and technology.

2) Assist the member states in developing a coordinated plan for research and training in the nuclear sciences.

3) Upon request from the member states, assist in solving specific problems of nuclear energy programs.

4) Provide a channel for scientific communication. The commission plans to publish a bulletin that will report activities in the nuclear sciences in the Americas. Conferences will be organized and sponsored by the commission to exchange knowledge about the peaceful application of nuclear energy.

The commission will be made up of one representative, "familiar with the nuclear energy programs of his country," from each of the 21 OAS member nations and will be headed by a chairman and vice-chairman elected for 1-year terms. Its secretariat will form part of the staff of the Pan American Union. Jesse D. Perkinson, Jr., chief of the Division of Science Development of the Union, has been appointed executive secretary of the commission. Creation of the new body is a result of the recommendations of the Inter-American Committee of Presidential Representatives, which was led by Milton Eisenhower, president, Johns Hopkins University.

Chinese Scientific Literature

The Lending Library Unit of Britain's Department of Scientific and Industrial Research has started to collect Chinese scientific literature. About 150 Chinese periodicals are now on regular order, and the first batch has arrived at the library's London premises (5–11 Regent St., London, SW 1).

Already the Lending Library Unit is noted for its large collection of Russian scientific literature, which is available to research, industrial, and other organizations. The library has also organized a scheme for translating Russian scientific literature in collaboration with the U.S. National Science Foundation. This project may possibly be extended in the future to include scientific literature from China. Meanwhile, the contents of these Chinese publications must be assessed, and a scientist with a knowledge of Chinese is being recruited by LLU to select and promote use of Chinese scientific and technological literature.

The Lending Library Unit in London is the nucleus of the new National Lending Library for Science and Technology, which will be set up at Thorp Arch, near Boston Spa, Yorks, in 1961.

News Briefs

The first medical research contract to be placed by the International Atomic Energy Agency was awarded in May to the department of clinical therapeutics of the University of Athens. Investigations with radioisotopes are expected to help in the treatment of certain types of anemia and of echinococcosis, a parasitic disease which forms cysts in the lungs and liver. These disorders are common in Greece as well as in several other subtropical regions of the world.

* * *

The Smithsonian Optical Tracking Station at Woomera, Australia, has successfully photographed the Vanguard I earth satellite at the apogee of its orbit, nearly 2500 miles from the earth. No other object as small as this 6-inch sphere has been photographed from such a distance. The Woomera station is operated for the National Aeronautics and Space Administration as a part of its world-wide network of tracking stations.

* * *

The National Aeronautics and Space Administration has formed a Committee on Long-Range Studies to deal with such nontechnical issues as the international, social, economic, and legal effects of space research and exploration. The committee's responsibilities center around that portion of the National Aeronautics and Space Act of 1958 which calls for "studies of the . . . problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes." Chairman of the committee is John A. Johnson, NASA's general counsel, and the executive secretary is Jack C. Oppenheimer, formerly attorney adviser in the Office of the Solicitor, Department of the Interior.

* * *

More than 2000 research-minded undergraduates will be given an opportunity, beginning this summer, to participate in biological, physical, and engineering research directed by college and university faculty members under a grant program announced in May by the National Science Foundation. The foundation has allocated $1,700,000 for the program to about 200 colleges and universities widely distributed throughout the nation. A list by states of the institutions to which grants have been made, and of the names of the directors, may be obtained from NSF, Washington 25, D.C.

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The Soviet magazine *Ogonyok* has published a public apology to Norbert Wiener, the American mathematician, for the denunciation of him and his work in cybernetics by the Soviet press during the period of Stalin's rule. Cybernetics, a field which Wiener is generally regarded to have founded, was heavily ridiculed in Russia during the early postwar years, and Wiener was denounced as an "obscurantist." The author of the apology, essayist Marietta Shaginyan, said that public recognition of the error in regard to Wiener's work was necessary to assure that those responsible do not repeat their errors in the future.

* * *

The first mossy-throated bellbird ever seen alive in any zoo has gone on exhibition in the Bronx Zoo's bird house. The specimen is one of the greatest rarities in the bird world; the name comes from the black, moss-like strings of flesh that hang in a large patch on the bird's throat. The Bronx Zoo specimen was captured on 6 April in the mountains of northern Trinidad by William G. Conway, curator of birds.

* * *

In Canada, a $600,000 contract for a design study of a new type of nuclear power reactor has been awarded to the Canadian General Electric Company, Limited. The reactor, known as OCDRE (Organic-cooled, Deuterium-moderated Reactor Experiment), is somewhat different from the type of nuclear reactor that Canada has developed to date; an organic liquid rather than heavy water is used to transfer heat from the uranium fuel to the steam generators. There has been a growing interest in the use of organic liquids as reactor coolants, for they cost about 40 cents a pound, compared to $28 a pound for heavy water.

* * *

Twenty-six Southern California high-school juniors have been selected for an intensive 7-week summer course in science, mathematics, and satellite-tracking at the Thacher School near Ojai. The course—first of its kind in the West and extending from 23 June to 11 August—is being sponsored by California Institute of Technology, the Helms Foundation, the Hughes Aircraft Company, the Ralph B. Lloyd Foundation, and the Thacher School. Richard Sutton, director of relations with secondary schools at C.I.T., is chairman of the program's executive committee.

* * *

The Canadian Society of Plant Physiologists was founded last fall at a meeting in Saskatoon, Saskatchewan. The new society grew out of a series of annual research conferences on plant physiology that had been held at various Canadian universities and research institutions over a period of 8 years. The president of the new society is Paul R. Gorham. Correspondence should be addressed to the secretary-treasurer, D. Siminovitch, Chemistry Division, Canada Department of Agriculture, Ottawa, Canada.

Scientists in the News

DON W. FAWCETT, professor and head of the department of anatomy at Cornell University Medical School since 1955, has been appointed Hersey professor of anatomy and head of the department at Harvard University, effective 1 July.

Lt. Gen. JAMES H. DOOLITTLE, chairman of the board of directors of Space Technology Laboratories, Inc., Los Angeles, Calif., has been awarded the Public Welfare Medal of the National Academy of Sciences, for "eminence in the application of science to the public welfare."

C. H. FISHER, director of the U.S. Department of Agriculture's Southern Utilization Research and Development Division, has received the 1959 Herty Medal of the American Chemical Society's Georgia section.

H. J. GREENBERG, acting manager of the International Business Machines Corporation's engineering science department, has been appointed manager of the mathematics theory department at I.B.M.'s Lamb Estate Research Center in Cortlandt, N.Y.

GERHARD J. HILDEBRAND has been appointed research physiologist at the Naval Biological Laboratory, School of Public Health, University of California, Berkeley.

JAMES A. REYNIERS, professor of bacteriology and founder and director of the Lobund Institute at the University of Notre Dame, has been appointed director of the Germfree Life Research Center, Tampa, Fla.

VINCENT DU VIGNEAUD, professor of biochemistry at Cornell University Medical College, has been named an honorary fellow of the Royal Institute of Chemistry, London, England.

THOMAS B. DREW, professor of chemical engineering and chairman of the nuclear engineering program at Columbia University, has been appointed visiting professor of chemical engineering at Massachusetts Institute of Technology for the academic year 1959–60. He will be on sabbatical leave from Columbia University.

MILDRED ALLEN, professor of physics at Mount Holyoke College, and ALICE H. FARNSWORTH, chairman of Holyoke's astronomy department for more than 30 years, will retire on 1 July.

Miss Allen, who received her A.B. from Vassar and her Ph.D. from Clark University, first taught at Mount Holyoke from 1918–20, and again between 1923–26. She has been on the faculty since 1933, and for 7 years she served as department chairman. Particularly interested in mechanics, intermediate electricity, heat, and optics, she has conducted research under C. L. Norton at Massachusetts Institute of Technology, W. F. G. Swann at Yale University and at the Bartol Research Foundation of the Franklin Institute; C. E. Howe at Oberlin College; and P. W. Bridgman at Harvard University.

Miss Farnsworth was graduated from Mount Holyoke in 1916 and returned in 1920 with M.S. and Ph.D. degrees from the University of Chicago, where she taught for a year. She was also a Martin Kellogg fellow at the Lick Observatory, University of California. Her principal research has been concerned with the space-absorption and luminosity function of stars in a region of the constellation Cassiopeia. She has also published numerous reports on occultations of stars with the moon, as well as on observations on sun spots which have been carried on continuously at Mount Holyoke since 1900.

MOSES G. JACOBSON recently retired from his position as research physicist with the technical products division of Mine Safety Appliances Company, Pittsburgh, Pa. He will remain with the company as a consultant.

OSMUND T. FUNDINGSLAND, manager of the microwave physics laboratory of Sylvania Electric Products, Inc., has been appointed director of research at the Raytheon Manufacturing Company, Waltham, Mass.

The following scientists have received the Department of Defense Distinguished Civilian Service Award, the highest honor conferred on civilian employees.

WALLACE E. DIETRICH, JR., supervisory general engineer, Bureau of Ships, Department of the Navy, for outstanding contribution to the design of ships for the Navy through development of a special analog computer.

HERBERT FRIEDMAN, superintendent, Atmosphere and Astrophysics Division, U.S. Naval Research Laboratory, Department of the Navy, for development of radiation detection devices and the conduct of important research in astronomy and astrophysics, including the first ultraviolet rocket survey of the celestial sphere.

EZRA KOTCHER, technical director, Wright Air Development Center, Wright–Patterson Air Force Base, Department of the Air Force, for exceptional contributions during the past 12 years to "strategic concepts and decisions of the greatest importance to the defense of the United States and the free world."

JOHN S. PATTON, air intelligence specialist, headquarters, U.S. Air Force, Department of the Air Force, for his outstanding accomplishments as an engineer, scientist, and educator over a period of 30 years.

ALVIN G. WAGGONER, civilian executive assistant to the director of guided missiles, Office of the Secretary of Defense, and executive secretary of the Office of the Secretary of Defense Ballistic Missiles Committee, in recognition of his exceptional contributions to the national guided missile and space program.

ESA HYYPPÄ, director of the Pleistocene Division of the Finnish Geological Survey, will visit this country in July and August to inspect evidence connected with the ice age. Appointments for conferences with Hyyppä on his travels in the Middle West, Far West, and Canada may be made with Prof. R. J. Lougee, Clark University, Worcester, Mass.

MILES D. McCARTHY, chairman of the department of zoology at Pomona College, will resign next fall to become chairman of the science division of the new Orange County State College at Fullerton, Calif.

The Royal Society, London, England, has elected the following new foreign members:

MELVIN CALVIN, physical chemist at the University of California.

GERHARD DOMAGK, bacteriologist at the University of Munster, Germany, and director of the Farbenfabriken Bayer Research Laboratories.

JAN H. OORT, astronomer and specialist in galactic structure at the University of Leiden, the Netherlands.

AXEL H. T. THEORELL, enzyme chemist at the Nobel Medical Institute, Stockholm, Sweden.

JOHN A. D. COOPER, professor of biochemistry at Northwestern University, has been named associate dean of the university's Medical School.

Sir SOLLY ZUCKERMAN, deputy chairman, Advisory Council on Scientific Policy, Office of the Lord President of the Council, Privy Council Office, London, will lecture at California Institute of Technology during the months May and June. He will also visit New York and Washington.

CHARLES YANOFSKY, assistant professor of biology at Stanford University, has received the $1000 Eli Lilly Award for outstanding research in microbiology. The presentation took place at a recent banquet of the Society of American Bacteriologists.

The following awards were among those presented during the American Chemical Society's 135th national meeting.

CEDOMIR M. SLIEPCEVICH, associate dean and head of the University of Oklahoma School of Engineering, has received the $3000 Ipatieff Prize.

FRANTISEK SORM, general secretary of the Czechoslovak Academy of Sciences and director of the academy's Chemical Institute, has received the Fritzsche Award, sponsored by Fritzsche Brothers, Inc., New York.

HARRY F. LEWIS, vice president and past dean of the Institute of Paper Chemistry, Appleton, Wis., has received the Scientific Apparatus Makers Award.

JOHN E. WILLARD, dean of the University of Wisconsin Graduate School, has received the ACS Award for Nuclear Applications in Chemistry, sponsored by the Nuclear Chicago Corporation.

ERNEST M. GRUNWALD of the Florida State University, has received the ACS Award in Pure Chemistry, sponsored by Alpha Chi Sigma.

JAMES I. HOFFMAN, head of the metallurgy division of the National Bureau of Standards, Washington, D.C., has received the Fisher Award in Analytical Chemistry.

PAUL BERG of Washington University has received the Eli Lilly and Company Award in Biological Chemistry.

CHARLES A. ZITTLE of the U.S. Department of Agriculture's Eastern Regional Research Division, Philadelphia, has received the ACS Award in the Chemistry of Milk, sponsored by the Borden Company Foundation, Inc.

JOHN C. SHEEHAN of the Massachusetts Institute of Technology has received the ACS Award for Creative Work in Synthetic Organic Chemistry, sponsored by the Synthetic Organic Chemical Organization.

EDWIN R. GILLILAND of Massachusetts Institute of Technology has received the ACS Award in Industrial and Engineering Chemistry, sponsored by the Esso Research and Engineering Company.

GEORGE C. PIMENTEL of the University of California has received the ACS Award in Petroleum Chemistry, sponsored by the Precision Scientific Company.

H. HOWARD CARY, president of the applied Physics Corporation, Monrovia, Calif., has received the Beckman Award in Chemical Instrumentation.

MINOR J. CONN of the University of Michigan has received the Paul-Lewis Laboratories Award in Enzyme Chemistry.

FLOYD E. BARTELL of the University of Michigan has received the Kendall Company Award in Colloid Chemistry.

JOHN RODGERS, associate professor of geology at Yale University, has been awarded a National Science Foundation senior postdoctoral fellowship and will take a year's leave of absence to study the structural geology of the Alpine ranges with Paul Fallot, professor at the Collège de France, Paris. Rodgers will return to Yale in September 1960.

S. WARREN CAREY, professor at the University of Tasmania, Australia, will be visiting professor of geology at Yale University during the academic year 1959–60.

LEONARD BERTIN, formerly with *Financial Post,* Toronto, Canada, has joined the Toronto *Daily Star* and the *Star Weekly* as science editor.

BRUCE H. BILLINGS, vice president and director of Baird-Atomic, Inc., Cambridge, Mass., has been appointed assistant director of research and engineering, Department of Defense.

CHAJIRO LONIZAWA of the National Institute of Agricultural Sciences, Tokyo, Japan, will spend 3 months this summer working at the Insect Physiology Laboratory of the Entomology Research Division, U.S. Department of Agriculture.

JAMES H. MEANS, Jackson professor emeritus of clinical medicine at Harvard University and former chief of medical services at the Massachusetts General Hospital, delivered the annual Gay lecture on medical ethics at the Harvard Medical School.

HANS NEURATH, professor of biochemistry and executive officer at the University of Washington, has been presented with a citation from the Austrian federal minister of education for outstanding merit in making the 4th International Congress of Biochemistry a success.

AKE HANNGREN of the University of Stockholm's Karolinska Hospital, Stockholm, Sweden, and a specialist in the study and treatment of tuberculosis and chest diseases, will be at the University of Chicago's department of pharmacology for 6 months. He will join Lloyd J. Roth, associate professor of pharmacology in a study of new antituberculosis drugs.

RICHARD F. POWELL, professor of chemistry at the University of California, Berkeley, has received the College Chemistry Teacher Medal of the Manufacturing Chemists' Association. The $1000 prize will be presented on 11 June at the association's 87th annual meeting, which was held in White Sulphur Springs, W. Va.

WALTER M. ELSASSER, professor of theoretical physics at Scripps Institution of Oceanography and the University of California, La Jolla, has received the William Bowie Medal of the American Geophysical Union.

Recent Deaths

ELMORE E. BUTTERFIELD, New York; 77; retired physician and chemical consultant; specialist in hematology and pathology; chief chemist at the chemical and physical testing laboratories of the Queens Borough President's office, 1918–29; instructor in pathology at the University of Michigan, 1904–06; author of *A History of the Lorentz Transformations in Mathematical Physics;* 16 May.

EDWARD W. GIFFORD, Berkeley, Calif.; 71; retired in 1957 as professor of anthropology at the University of California; associate curator of the university's Anthropology Museum before joining the faculty in 1920 as a lecturer; vice president of the American Anthropology Association in 1943; 15 May.

CARROLL W. GRIFFIN, Poughkeepsie, N.Y.; 58; chairman of the department of chemistry at Vassar College, and a faculty member since 1932; research associate in chemistry at Rutgers University, 1931–32; chairman of the department of chemistry at Mississippi Woman's College, 1929–31; former associate professor of chemistry at Brenau College (Ga.); author of sections in his field in the *Encyclopedia Americana,* and of a textbook, *Inorganic Quantitative Analysis;* 4 May.

GEORGE T. JORDAN, Vermillion, S.D.; 83; retired Chicago physician and a former president of the National Association of Ophthalmologists; at his death, chief of staff at the Dakota Hospital, and a faculty member of South Dakota University's Medical School; former head of the Eye, Ear, Nose and Throat Department of Mercy Hospital, Chicago; had taught at Loyola University; 17 May.

J. GORDON LEE, Silver Spring, Md.; 56; noted for his work on head and neck surgery; chief surgeon at the Mount Alto Veterans Administration Hospital, Washington, D.C., since 1948; adjunct professor of clinical surgery at the medical schools of Georgetown and George Washington universities; founder of the American Board of Traumatic Surgery; 11 May.

ANTOINETTE R. PETERSON, New York; 88; founder and treasurer of the old Child Health Organization, that merged in 1923 with the American Child Hygiene Association to form the American Child Health Association; had worked with the late L. Emmett Holt, famous child specialist: 19 May.

Book Reviews

The American College President. Harold W. Stoke. Harper, New York, 1959. ix + 180 pp. $3.50.

This is a good book in every respect. College and university presidents who read it will find themselves nodding in agreement and wanting to make it required reading for faculty members, trustees, and publicists.

Stoke, in this nicely written explanation and interpretation of the job of college president, has proved himself to be an analyst of a high order. As president of Queens College, he knows all of the urges, ambitions, and challenges, all of the joys, exhilarations, and satisfactions involved; but he also shows a keen appreciation of the causes of vicissitudes, frustrations, and failures which fall to the lot of the vast majority of college presidents.

It is really quite an accomplishment that in 171 pages the author has been able to weave into one meaningful tapestry so many divergent factors whose haphazard occurrence makes the president's calendar interpretable only to himself and his secretary. Stoke deals with problems concerning fund-raising, academic freedom, the "pathology of administration," deans, *in loco parentis,* alumni, intercollegiate athletics, "duty speeches," fringe benefits, "learning versus competence," curricular changes, proliferation, faculty rivalries, salaries, budgets, correspondence galore, public versus private institutions, management skills, higher education as big business, selection of new faculty members, visiting speakers, publications, fraternities, student rating of professors, campus tensions, tenure, clinics of all kinds, housekeeping problems, more "duty speeches," more correspondence, and more fund-raising. Into this tapestry he weaves all of those things under the chapter headings: "The vested authority," "Personal problems," "The administrator," "Everything takes money," "Boards of trustees," "Public relations," "Among the scholars," "The students," "The uneasy campus," and a final splendid chapter on "The uses of a philosophy of education."

In his preface Stoke says that this book is meant to be "an interpretation of an important part of higher education, a report on some of the problems of the president, and an indication of some of the pleasures and pains of his position." He says that he has written these comments for "administrator, faculty member, alumnus, trustee, and the general reader," for everyone "who is genuinely concerned about the improvement of American higher education."

Now if other college presidents somehow can get their faculty members, their trustees, and other persons of influence to read this book, the average tenure in office of presidents (now 4 years) may be lengthened to approach the 6 years enjoyed by football coaches. Great strides in the advancement of American education would then result.

CLANTON W. WILLIAMS
University of Houston

Physiology of Fungi. Vincent W. Cochrane. Wiley, New York; Chapman & Hall, London, 1958. xiii + 524 pp. Illus. $9.75.

The history of mycology has, in a sense, been a miniature of the history of biology as a whole. The early studies on fungi were primarily taxonomic; they were followed by a period of morphology, and later the comparative approach was adopted. Finally, there has been a period of physiological and biochemical studies. Of course, this history reflects an expansion rather than a succession, because the specialties which began early have remained as vigorous and essential components of the discipline. Moreover, each specialty did not begin immediate, rapid growth, but exhibited a sort of growth curve. The study of some aspects of the physiology of fungi, for example, began relatively early; other aspects which required more sophisticated techniques or backgrounds drawn from other disciplines have begun only recently. In any event, it is perhaps an indication of the recentness of the widespread study of the physiology of fungi that there was no single, reasonably complete treatise on the subject before World War II. It is a measure of the rapid growth of the field that five monographs in English have appeared during the past decade.

The first question that a reviewer should attempt to answer is "How does this book compare with its predecessors?" In the case of *Physiology of Fungi,* one answer is simple: it is without doubt the most comprehensive and best balanced book on the subject that has yet appeared. Substantiation for this assertion is only partially to be found in the chapter headings, because each chapter contains many subheadings and a multitude of facts. The major topics treated are: growth of fungi, the composition of fungus cells, carbon, nitrogen, inorganic nutrition and metabolism, vitamin requirements, reproduction, spore germination, and the action of physical and chemical agents on fungi. Discussion of all of these topics is available in one or another of the books published in the last decade, but here they are all in one book, and the space allotted to each is equitable.

The very comprehensiveness of the book is responsible for one of its limitations, because, even with the field of coverage limited to the physiology of filamentous fungi and aerobic actinomycetes, it treats such a multiplicity of subjects that it is impossible for an author to discuss any one topic in detail. For the most part, however, the book is more than an annotated bibliography. The references were selected carefully, and the material was evaluated critically and interpreted objectively, albeit briefly. In most cases, the papers referred to must be consulted for details. The book is logically organized and is written in a clear, conservative style. Despite the winnowing of references, the bibliography is extensive.

Some people will be disappointed that *Physiology of Fungi* is not a textbook, but it is much too detailed for use in any but advanced courses. On the other hand, advanced students as well as professional workers in mycology, plant physiology, "microbiology," and cellular physiology will find this scholarly book a useful and perhaps stimulating reference work. As an inventory of the present status of knowledge concerning the physiology of fungi, the book should help to promote the further growth of the field.

ROBERT M. PAGE
Department of Biological Sciences, Stanford University

Colorimetric Determination of Traces of Metals. E. B. Sandell. Interscience, New York, ed. 3, 1959. xxii + 1032 pp. Illus. $24.

Analytical chemists will welcome the appearance of this third edition of a book which for 15 years has been the standard reference on colorimetric methods for determining microgram and submicrogram quantities of metals. The

simplicity and elegance of these methods have led to a great extension of their use during the past decade, and the book is correspondingly much larger (and unfortunately much more expensive) than the preceding (1950) edition.

The revision is a thorough one; large sections of the book have been completely rewritten in order to bring it abreast of recent developments. Even paragraphs whose content is not appreciably changed have been gone over with meticulous care to improve the clarity and smoothness of the wording. The main body of the text includes discussions of methods published up to 1957, and literature references through 1958 have been added as supplements to most chapters.

The organization of the book remains unchanged. About one-fifth of its thousand pages is devoted to a general discussion of the methods, materials, and apparatus used in trace analysis. The advantages and limitations of colorimetric methods are explained in detail, methods of separating and isolating small amounts of metals are considered, and the various colorimetric reagents are discussed critically. The remaining four-fifths of the book takes up the metals in alphabetical order and for each one describes methods of separation, analytical procedures, and applications of the procedures to various kinds of material. Among the analytical procedures for each element the author selects the one that he considers most generally useful; he explains its merits and demerits and describes the necessary apparatus, reagents, and sequence of operations in great detail. For many elements this sort of detailed treatment is given for several alternative methods.

In the new edition all parts of the book have been expanded in about the same ratio. Sections of the early chapters which are wholly new or of greatly increased length include those on radioactivation analysis, preparation of biological material, chromatographic and ion-exchange separations, extraction of metals by immiscible solvents, indirect colorimetric methods, and fluorimetry. In the chapter on colorimetric reagents the most prominent addition is a long section on the details of dithizone-dithizonate equilibria; an indication of how rapid recent progress has been is the fact that the second edition gave only two approximate equilibrium constants for such reactions (silver and copper), whereas the new edition has a two-page table listing constants for most of the metals that react with dithizone. In the chapters devoted to individual metals, the most conspicuous additions are frequent descriptions of separation procedures involving ion exchange and chromatography and directions for applications of colorimetric procedures to a much greater variety of materials, particularly to metals and alloys. Innovations under particular metals are too numerous for listing, but the following will serve as examples: new methods introduced as the favored ones (persulfate for cerium, phenylfluorone for germanium, rhodamine-B for gallium and thallium, thoron for lithium, alizarinsulfonic acid for scandium); great expansion in the number of methods and the amount of description given for niobium, tantalum, uranium, zirconium, and the platinum metals; a completely new chapter on thorium; great increase in the detail given for methods previously described (especially those of rhodamine-B for antimony, 8-hydroxyquinoline for aluminum, dithiocarbamate for copper, and rhodanine for silver).

The great virtue of this book, in this edition as in the previous ones, is the thoroughness with which Sandell has digested the enormous literature on colorimetric reactions. Here is no mere listing of possible procedures; each method has been looked into carefully, the sensitivity and applicability of these methods under various conditions have been examined, and the advantages and disadvantages relative to other methods have been scrupulously considered. Many of the procedures have been exhaustively tested by Sandell and his students. For several elements the author admits freely that no satisfactory procedure is yet available; he describes the limitations of present methods and suggests leads that analysts might pursue in attempting improvements. The thoroughness of the discussion and the meticulous detail of the descriptions result in an enormous saving of time for analysts seeking to devise methods suitable for particular purposes.

One limitation of the book is the fact that its procedures are designed primarily for use in a completely equipped analytical laboratory. There is little discussion of the more rapid and often less sensitive methods of analysis that can be adapted for use in the field. In the chapter on copper, for example, the biquinoline method is casually dismissed because the reagent is expensive and somewhat less sensitive than others; the specificity of biquinoline and the remarkable stability both of the reagent and of its copper compound—properties that have so endeared it to field workers—are evidently of secondary importance in Sandell's opinion. But this is hardly a valid criticism, since to include a discussion of field methods would increase still further the size of a book that is already straining the limits of a single volume.

The format of the book has been improved by the substitution of italics for bold-face type in many of the side headings, and by the use of larger type for several of the tables. Typographical errors are remarkably few in number for a book that has undergone such thorough revision.

Analysts in many fields owe Sandell a debt of gratitude for bringing together, sifting, and organizing so skillfully the presently available data on colorimetric methods for traces of metals.

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Polar Atmosphere Symposium. Part 2. Ionospheric section. K. Weeks, Ed. Pergamon Press, New York, 1957. xiii + 212 pp. Illus. $10.50.

The Oslo symposium on the polar atmosphere, which dealt with both meteorology and ionospheric physics, resulted from a suggestion to AGARD (Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization) by L. Harang of the Norwegian Defence Research Establishment. The ionospheric section was organized according to three areas of interest: drifts and movements in the ionosphere (10 papers), ionospheric prediction in high latitudes (7 papers), and scattering of radio waves by the ionosphere (4 papers). The proceedings include a record of the discussion which followed each group of papers. The opening address by F. L. Wattendorf (director of AGARD), who explained how AGARD grew out of the suggestion of T. von Kármán (California Institute of Technology) and the introduction speech by H. U. Sverdrup, who drew upon his wealth of personal experience to interpret the objectives of the conference, are included. The record of Sverdrup's speech is especially valuable because of his death only a year later. Sverdrup was an oceanographer and meteorologist of much renown. At his death he was director of the Norsk Polarinstitutt in Oslo and deputy rector and professor of geophysics at the University of Oslo. From 1936 to 1948 he was professor of oceanography and director of the Scripps Institution of Oceanography at the University of California. He organized the highly successful Norwegian-Swedish-British Antarctic Expedition of 1949–52.

The record reflects the fact that the meeting was strictly scientific in character. Only by listing and commenting on each of the 21 papers would it be possible to summarize the scientific progress made and give suitable credit to the contributors. However, most of those who are interested in this field regularly see the *Journal of Atmospheric and Terrestrial Physics,* and this same record of the symposium was published as a special supplement to that journal in 1957 as well as in this hard-cover edition.

Part I, recording the proceedings of the meteorological section of the meeting, was also published in 1957 as a special supplement to the same journal as well as in the hard-cover edition.

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The College Influence on Student Character. An exploratory study in selected colleges and universities. Edward D. Eddy, Jr. American Council on Education, Washington, D.C., 1959. xii + 185 pp. $3.

In this study the provost of the University of New Hampshire and two recent college graduates (Mary L. Parkhurst and James S. Yakovakis) have contributed a most sensitive understanding of influences in college which have a lasting effect on students. The study was prepared for the American Council on Education because the council felt an "urgent necessity to develop in oncoming generations the strength of character to match the responsibilities that will be heaped upon the educated leader."

The purposeful search of the investigators for experiences inside and outside the formal educational process which touch the intangible phenomenon called "character" was conducted in a way which gives the findings unusual authenticity. Extended, on-the-spot observation at a diverse group of colleges, was coupled with incisive discussions with students, faculty, and counselors to produce fresh, lively, and strikingly candid testimony about what actually happens to students, in a personal sense, as they go through college.

The accent of the findings is impressively positive, but not complacent. Students respond when they are given responsibility, but it must be real, not fictitious, responsibility. They rise to a high level of performance, moral as well as intellectual, when a high level of expectancy on the part of the college community challenges them. They do build upon the insights of the teacher who has integrity and vision, but he must be a genuine article, for students quickly detect a "phony."

The central conclusion is that the dual goals of intellectual excellence and force of character are inextricably interwoven in the truly educated man. So the elements in the campus community which encourage character are those which also encourage learning. "The college," these observers believe, "finds its greatest contribution to the student in the Socratic theme that the unexamined life is not worth human living." Excellence of character will emerge as students are prodded to a more searching and strenuous intellectual development.

This vindication of the academic vocation in terms of its moral potential does not agree with the profile drawn of contemporary college experience in several other recent studies. Many students today can apparently refine their intellect without a corresponding enrichment of character. They seal off their moral control tower—the mechanism by which they reach value judgments—from the influx of intellectual communications. On many an American campus, a hiatus splits the educational process from the real life of students and the student's learning from the values he holds. An educated but morally *irresponsible* college graduate probably emerges far more frequently from the academic assembly line than does Eddy's intellectual of "Socratic-character."

What makes this inquiry so significant, however, is that it may have hit upon some of the vital influences which make the difference in the human outcome of the educational process. The Eddy report might well have been subtitled "A guidebook on how to avoid futility in liberal education." To educators concerned with the growth of the person as well as the mind of their students it will furnish encouragement and direction as they struggle against sweeping automation in the college industry.

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Free Radicals as Studied by Electron Spin Resonance. D. J. E. Ingram. Academic Press, New York; Butterworths, London, 1958. 274 pp. Illus. $9.50.

The development of paramagnetic resonance spectroscopy has opened new avenues in free radical research. Information and knowledge in this field have increased rapidly in recent years, and considerable future advances have to be anticipated. In this situation the monograph by Ingram fills an urgent need: it gives an excellent introduction to the field and a critical, systematic evaluation of the available experimental data.

The first four chapters of the book deal with the "unchangeable" facts: basic ideas, well-established experimental designs and methods, and basic molecular theory. The following five chapters discuss and summarize applications and achievements—physical, organic and biochemical, biological, and medical—in the physics of the field where many new facts have been discovered and existing theories could be confirmed. Of special interest are the applications of the method to radiobiological problems, where the existence of long-lived, radiation-produced radicals could be demonstrated and where the method is soon to be applied for the measurement of the life span of short-lived radicals produced in biological systems during irradiation.

Thus, the book will be more than a reliable source book of information and knowledge; it will also be a guide to further research in this steadily-growing important field. It is one of the standard works on free radical research which should be available in every laboratory.

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The Gulf Stream. A physical and dynamical description. Henry Stommel. University of California Press, Berkeley; Cambridge University Press, London, 1958. xiii + 202 pp. Illus. $6.

This well-written and stimulating book is a noteworthy contribution to the literature of oceanography and geophysics. The author summarizes the distribution in the northwestern Atlantic of temperature, salinity, other properties that characterize certain features of the Gulf Stream. However, he is careful to point out that although the name of this great ocean current is a familiar one, it is no easy matter to describe it accurately. The observational data can be interpreted in a variety of ways, depending upon the preconceived ideas of the compiler and the geographic pattern of the observations available to him. The computed values of current velocity and volume transport depend upon the selection of the level of no motion; even direct measurements of current are subject to these same uncertainties. In part these problems reflect the lack of adequate theories that should provide a model that could then be tested by properly planned field measurements. However, the theoretical oceanographer has been handicapped by the lack of an adequate description of the phenomenon he attempts to explain. This has led to what Stommel calls "the peculiar dreamlike qualities" that have characterized many of the descriptions and discussions of ocean currents. Stommel has made great contributions in recent years to a more rational attack on the problem of oceanic circulation.

The greater part of the book is devoted to a review of the theories of ocean currents. Stommel has broad theoretical interests, and he has also made many original observations on the Gulf Stream. Because of his background and interests he is uniquely qualified to write this book. Since its establishment in 1931,

the Woods Hole Oceanographic Institution has devoted a great deal of effort to the study of the Gulf Stream, and it is most fitting that this book should be written by a member of its staff.

For the oceanographer, the volume represents a valuable synthesis of information and theories; and for the worker in other fields, particularly those in the physical sciences, it will provide insight into some of the complex but poorly understood phenomena of the ocean. With this book at hand the future studies of the Gulf Stream and of oceanic circulation in general should move forward at an accelerated pace.

In an otherwise excellent work it is unfortunate that the author did not give more attention to the illustrations. This is particularly true in the descriptive sections where the illustrations have generally been copied from the original sources without regard to map projections, areas covered, scales, or units. Oceanographers are accustomed to this confusion, but other readers will have to examine the illustrations with caution.

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The Vertebrate Story. Alfred S. Romer. (a revised and enlarged edition of *Man and the Vertebrates*). University of Chicago Press, Chicago, Ill., 1959. vii + 437 pp. Illus. $7.

This is a fourth edition of the well-known book *Man and the Vertebrates,* with a new Hollywood title, more natural history, and less human anatomy. Though the changes are important ones, the purposes of the book remain the same. It is a taxonomic review of the vertebrates, including man, with enough anatomy and physiology to form a good picture of the kinds of lives led by the various groups and put together as an account of their evolution. The illustrations are clearer and more plentiful than they were in the last edition (1941), and the format of the book is considerably improved.

In the earlier book, man and the rest of the vertebrates were given about equal shares, but in the new one the division is about one to three. A large section on human anatomy has been omitted in favor of a more extensive treatment of the lower groups of vertebrates. The old 30-page chapter on frog anatomy remains, but there are now 15 more pages on teleosts, 36 more on reptiles, 12 more on birds, and one finds new or revised paragraphs all through the book. Human ancestry and human races take up the last hundred pages. The section on human origins has been slightly enlarged, and Piltdown man has been changed from a problem to a hoax, but this edition was apparently in the works too soon to permit the new Oreopithecus material to be included.

Other areas of great current interest seem to have been systematically avoided. Jaymoytius is not in the book, and the Ichthyostegalia are not discussed. The lungfishes are still "close to the ancestry of land animals," and are put in the same class with crossopterygian fishes, though Romer has changed his earlier name for this grouping from Choanichthyes to Sarcopterygii. *Latimeria* gets an extra paragraph in this edition, but, unfortunately it also picks up an extra lung. Vexing questions of the relationship of classes and subclasses of ancient fishes, and of the origins of amphibian groups, are bypassed.

This avoidance of technicality and controversy at least favors the maintenance of a storybook tone. Romer's genial, conversational style comes out best of all in the new sections. His animals, even his fossils, come alive. There are stimulating samples of his recent speculations on such subjects as the origin of vertebrates (probably from sessile filter-feeders related to echinoderms), the origin of the terrestrial habit (the amniote egg came ashore first), and "Gondwanaland" (who knows, why not?). This certainly remains a text to be preferred for an elementary course on the biology of vertebrates, or for painless self-education.

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New Books

Hunger and Food. Special edition of *Science and Mankind.* Josue de Castro, Ed. World Federation of Scientific Workers, London, 1959. 123 pp. 10s.

Industrial Fatty Acids and Their Applications. E. Scott Pattison. Reinhold, New York; Chapman & Hall, London, 1959. 236 pp. $7.

Introduction to Human Anatomy. Carl C. Francis. Mosby, St. Louis, ed. 3, 1959. 548 pp. $5.75.

The Journals of Daniel Noble Johnson (1822–1863). "Journal of a cruise on the Brazils on Board of the U.S. Ship *Delaware,* 1841–1842" and "Notes by the way while on board the U.S. Schooner *Enterprise.*" Misc. Collections, vol. 136, No. 2. Mendel L. Peterson, Ed. Smithsonian Institution, Washington, D.C., 1959. 268 pp.

Knowing Your Trees. 1955 edition. G. H. Collingwood and Warren D. Brush. American Forestry Assoc., Washington, D.C., 1955. Approximately 850 illustrations showing typical trees and their leaves, bark, flowers, and fruits.

Linguistic and Engineering Studies in the Automatic Translation of Scientific Russian into English. Technical report, prepared for the Intelligence Laboratory, Rome Air Development Center. ASTIA Document No. AD-148992. Erwin Reifler. Univ. of Washington Press, Seattle, 1959. $10. (not paged)

The Lost Divisions. Eli Ginzberg, James K. Anderson, Sol W. Ginsburg, John L. Herma. Columbia Univ. Press, New York, 1959. 245 pp. $6.

Magnetic Amplifier Engineering. George M. Attura. McGraw-Hill, New York, 1959. 234 pp. $7.50.

Méthodes mathématiques de la mécanique statistique. A. Blanc-Lapierre, P. Casal, A. Tortrat. Masson, Paris, 1959. 190 pp. F. 3800.

Modern Transistor Circuits. John M. Carroll. McGraw-Hill, New York, 1959. 280 pp. $8.50.

Natural Selection and Heredity. P. M. Sheppard. Philosophical Library, New York, 1959. 212 pp. $6.

The New World of Math. George A. W. Boehm and the editors of *Fortune.* Dial Press, New York, 1959. 128 pp. $2.50.

Nucleonics Fundamentals. David B. Hoisington. McGraw-Hill, New York, 1959. 422 pp. $9.50.

Our Atmosphere. Theo Loebsack. Translated from the German by E. L. and D. Rewald. Pantheon, New York, 1959. 256 pp. $5.

Patterns of Performance. Eli Ginzberg, James K. Anderson, Sol W. Ginsburg, John L. Herma. Columbia Univ. Press, New York, 1959. 359 pp. $6.

Plane Trigonometry. Raymond W. Brink. Appleton-Century-Crofts, New York, ed. 3, 1959. 350 pp. $4.

Plants and Environment. A textbook of plant autecology. R. F. Daubenmire. Wiley, New York; Chapman & Hall, London, ed. 2, 1959. 433 pp. $6.95.

Power Unlimited. The story of power —from windmill to nuclear energy. Abraham and Rebecca B. Marcus. Prentice-Hall, Englewood Cliffs, N.J., 1959. 160 pp. $3.50.

Principles of Self-Damage. Edmund Bergler. Philosophical Library, New York, 1959. 483 pp. $6.

Psychoanalysis, Scientific Method and Philosophy. A symposium. Sidney Hood, Ed. New York Univ. Press, New York, 1959. 383 pp. $5.

Radiation Biology and Cancer. Published for the University of Texas M. D. Anderson Hospital and Tumor Institute. Univ. of Texas Press, Austin, 1959. 501 pp. $8.50. This collection of papers, presented at the twelfth annual symposium on fundamental cancer research, is divided into the following sections: "Fundamental radiobiology"; "Radiological applications"; "Radiation effects on the hematopoietic system"; "Induction of neoplasia by ultraviolet light"; "Induction of neoplasia by ionizing radiations"; "Radiation biology and cancer"; and "Medical applications of radiation." The Bertner Foundation lecture, "Radiation neoplasia and endocrine systems" by Jacob Furth, is included in this volume.

Railroad Transportation and Public Policy. James C. Nelson. Brookings Institution, Washington, D.C., 1959. 520 pp. $7.50.

Researches in Geochemistry. Philip H. Abelson, Ed. Wiley, New York; Chapman & Hall, London, 1959. 521 pp. $11.

Reports

Storage of Steroid Hormones by Adipose Tissue in Two Experimental Obesities

Abstract. It appears that obese animals retain proportionally more steroid hormones than nonobese animals. The retention of these hormones does not appear to be a function of the nature of the obesity syndrome but simply a function of the increased fat content.

It has been shown that obesity in mice can be grouped into two general classes: "regulatory" obesity, in which the primary lesion lies in the nervous centers regulating food intake, and "metabolic" obesity, in which the hyperphagia is secondary to metabolic disorders of carbohydrate and fat metabolism (*1*). Since these two classes of obese mice differ markedly with respect to lipogenesis and cholesterologenesis (*2*) as well as enzymatic reactivity (*3*), feeding patterns (*4*), and so on, it seemed to be of interest to determine the characteristics of retention of administered steroid hormone in the two types of obesity.

If retention of administered hormone were entirely due to the amount of fat present, one would expect a direct correlation between retention and fat content, whether in normal animals, in animals with regulatory obesity, or in animals with metabolic obesity. A deviation from this pattern would suggest that specific factors influence steroid retention of fat.

Accordingly, mice with goldthioglucose hypothalamic (regulatory) (*5*) obesity and mice with the hereditary obese-hyperglycemic (metabolic) syndrome (*6*) and their controls were used to study the retention of testosterone and progesterone. A wide range of weights was used in each group. The steroids retained by adipose tissue were identified by chromatography, and retention was determined by measurements of radioactivity. The technique was similar to that used by Plotz and Davis (*7*) and by Zander (*8*) in their study on the retention of progesterone in the fatty tissue of pregnant women.

Ten female goldthioglucose obese mice (36 to 58 g), six nonobese female controls (20 to 32 g) and eight obese hyperglycemic mice (four males, four females, weighing 45 to 91 g) with their nonobese controls (4 males, 4 females, weighing 20 to 35 g), were used in the testosterone study.

Three obese-hyperglycemic mice (one male, two females, weighing 48 to 71 g) with their nonobese controls (one male, two females, weighing 20 to 30 g), as well as four goldthioglucose obese mice (females, 32 to 40 g) and four nonobese controls (females 22 to 29 g) were used in the progesterone experiment.

The mice were injected intramuscularly with either 5 or 10 μc of testosterone-4-C^{14} (1.21 mg or 2.42 mg) or with 10 μc of progesterone-4-C^{14} (0.33 mg) dissolved in sesame oil. The mice were placed in individual metabolism cages for 18 hours. Urine and feces were collected during this time interval. At the end of 18 hours, the mice were killed by decapitation, and adipose tissue was removed and extracted for 12 hours with ether/95 percent ethanol (3:1). The extracted fat was partitioned between heptane and 70 percent methanol (heptane fractions were counted to check the completeness of the extraction). Carrier steroids were added to the methanol extracts. These extracts were chromatographed by the Zaffaroni (*9*) system with heptane/propylene glycol as the solvent system. Testosterone, etiocholanolone, and androsterone zones (testosterone-C^{14} study) and progesterone (progesterone-C^{14} study) were eluted from the chromatogram. The radiochemical purity of the C-19 steroids and of the progesterone was determined by Bush-type wash-out chromatogram (*10*), acetylation and chronic acid oxidation (C-19 steroids), and dinitrophenylhydrazine derivative (progesterone). Retention was determined by measurement of radioactivity.

The majority of the methanol extracts from adipose tissue were treated in the manner described above. However, a few samples were chromatographed with the toluene/propylene glycol system. In this solvent system, corticoids and estrogens would be retained on the paper. However, since only negligible activity was found in these fractions, the remainder of the samples were directly chromatographed in the heptane/propylene glycol system for isolation of C-19 steroid and progesterone.

In the testosterone-C^{14} experiment the major portion of the activity retained in adipose tissue was present in the testosterone (96 percent), etiocholanolone (2 percent) and androsterone (1 percent) fractions. Progesterone accounted for most of the retained activity (93 percent) in the progesterone-C^{14} experiment, with the corticoid fractions accounting for about 1 to 3 percent of the activity and 1 percent in the fractions containing substances less polar than progesterone.

Most of the administered testosterone or progesterone is excreted in the urine and feces of the mice at the end of 18 hours. Similar results were obtained by Gallagher *et al.* (*11*) in studies on recovery of administered testosterone-4-C^{14} and progesterone-21-C^{14} in excreta and tissues of normal mice. However, the activity retained by adipose tissue

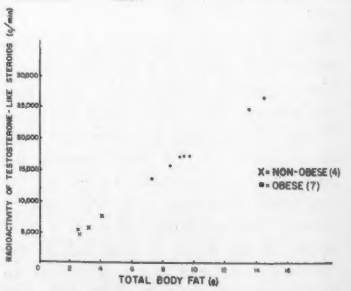

Fig. 1. Steroid hormone retention in adipose tissue after administration of testosterone-4-C^{14} to goldthioglucose obese and nonobese mice.

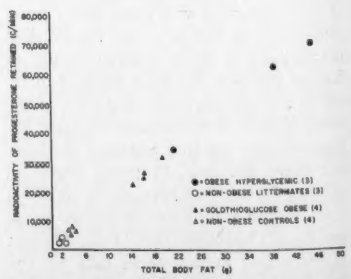

Fig. 2. Steroid hormone retention in adipose tissue after administration of progesterone-4-C^{14} to two kinds of obese mice.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

ranges from 0.24 to 5.2 percent of administered testosterone-4-C^{14} activity and from 0.19 to 4.3 percent of administered progesterone-4-C^{14} activity. This activity is correlated with the amount of fat present in the animals.

Figure 1 shows the total radioactivity of C-19 steroids plotted against grams of fat for goldthioglucose obese mice and nonobese controls given 10 μc of testosterone-4-C^{14}. This activity was measured 18 hours after injection. It is evident that retention of labeled hormone is proportional to the amount of fat, or to obesity per se. The same picture was found in goldthioglucose obese mice given 5 μc of testosterone.

Similar results were obtained with the obese-hyperglycemic mice—that is, retention of testosterone-C^{14} was proportional to the amount of fat present in obese and nonobese mice. In addition, C^{14} retention per gram of fat (1800 count/min per gram of fat for animals given 10 μc) was the same for both types of obese mice and their nonobese controls. For the various types of mice at the two doses studied after 18 hours, retention of testosterone was represented by the formula: percentage retention $= 1.3 + 0.05 \times 10^{-3} f$, where f is total body fat in grams.

Figure 2 shows the radioactivity present in the progesterone fraction plotted against the grams of fat for goldthioglucose obese mice, obese hyperglycemic mice, and their respective nonobese controls measured 18 hours after the injection of progesterone-4-C^{14}. As in the testosterone study, retention of labeled hormone is correlated with the amount of fat present regardless of the type of obesity or whether the mice are obese or nonobese. Carbon-14 retention per gram of fat is the same for all animals (1600 count/min per gram of fat in the progesterone study). Thus, although the obese-hyperglycemic mice and goldthioglucose obese mice differ markedly in fatty acid and cholesterol synthesis, retention of administered steroid hormone appears to be a physical phenomenon common to both groups because of their increased fat content. A large amount of excess fat in obese animals favors the retention of injected steroid hormones. This may have physiological consequences in that obese animals (and obese patients) may retain larger amounts of their own steroid hormones. It may also have therapeutic implications in that it appears likely that steroid hormones administered to obese patients may be stored in appreciable amounts in their fat depots (*11*).

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JEAN MAYER

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5. Goldthioglucose hypothalamic mice become hyperphagic and obese as a result of the destruction of the ventromedial area of the hypothalamus by a single injection of 1 mg of goldthioglucose per gram of body weight (*2*). No abnormality of carbohydrate or fat metabolism (outside of those secondary to hyperphagia) is present.
6. The hereditary obese hyperglycemic syndrome is a recessive condition characterized by obesity, hyperglycemia, hypercholesterolemia, increased hepatic glycogen turnover and phosphorylase, hyperplasia of the Islets of Langerhans, insulin resistance, sensitivity to cold and to growth hormone, increased lipogenesis and cholesterogenesis even under fasted conditions, increased pancreatic and circulating insulin, abnormalities in the metabolism of adipose tissue, and so forth (*2*).
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20 October 1958

Nervous Pathways of Cutaneous Pains

Abstract. In discussing the reality of a peripheral duality of pain-afferent systems, which she attributes to an artifact [*Science* **128**, 713 (1958)], M. H. Jones rejects as valueless data concerning differences in the velocity of conduction of nerve impulses as determined by reaction times. Yet precise data tend to show the reality of these differences in velocity.

I found it very strange that Margaret Hubbard Jones should maintain, on several occasions (*1*), solely on the basis of subjective data, that the duality of cutaneous pains is an artifact.

For a long time now the dissociation of cutaneous pain systems has been established, as I reported in detail in 1935, in an article in *Traité de Physiologie* (*2*).

Supporting data obtained from an analysis of reaction times were deliberately rejected by Jones, who cited a study by Lele, Sinclair, and Weddell (*3*) in support of her position.

Answering Libet (*4*), she declares, "Libet's emphasis on reaction time is unfortunate. None of the studies meet the minimum requirements for work in the field."

Actually, research studies of Lele *et al.* have shown that these reaction times do vary—something which has been known for a century. It was through variations in reaction time that Helmholtz measured, for the first time, in 1850, the velocity of the nerve impulse in afferent tracts, with an accuracy which afterwards proved satisfactory.

Of course, measurements should be planned under very precise conditions and made on trained and sufficiently coherent subjects (this was not the case in the research of Lele *et al.*); it is then possible to get mean values which are stable enough to be significant. A most important point lies in the use of constant physiological intensities, for reaction times depend on the intensity of the sensation, showing rapid variability around the threshold. For touch, a margin of about 230 msec between threshold intensity and an intensity 150 times greater (*5*) is found; narrower margins are sometimes met with, however, (*6*).

But Lele *et al.*, when comparing reaction times to stimulation consisting of equal pressures on a finger and on a toe, took no account of differences in the sensibility of their subjects and did not establish threshold values; hence, their comparison loses all its significance and their conclusions all their value.

In 1930 (*7*) I made a series of measurements of reaction times to such stimulations as painful pricking, burning, and pinching, the stimulations being so graded as to cause sensations of seemingly equal pain on the forehead (or the temple), the wrist, and the ankle.

Under such conditions (the dispersion indices of means computed on series of 20 being usually less than 10 percent), I found, for two nerve pathways each 80 cm long (between forehead and hand and between hand and foot), reaction-time differences of 235 and 216 msec for burning (by contact for forehead and hand, by immersion for hand and foot); differences of only 49 msec for pricking (either between forehead and hand or between hand and foot); and, finally, differences of 135 msec for pinching between temple and foot (that is, 68 msec for a pathway 80 cm long).

The resulting probable velocities of nerve impulses are about 4.50 m/sec for burning, 16 m/sec for pricking, and 12 m/sec for pinching, whereas for touch the velocity is about 40 m/sec, according to determinations which von Wittich established as early as 1868 (*8*) through study of reaction times.

In 1939, Zotterman (*9*), using tactual percussion, contact, pricking, and burning as stimulations on a cat's tegument innerved by the saphena, recorded four types of action potentials in this nerve: the fastest (30 to 60 m/sec) were correl-

ative with tactual percussion; the slowest, of the C group (2 to 5 m/sec), were related to burning; those generated by pricking had a velocity 20 to 30 m/sec; and finally, those due to irritative slight contacts which Zotterman thought might induce itching had a velocity of 8 to 17 m/sec and were related to the A group, δ type fibers.

As I pointed out (*10*), it appears to me that there is remarkable agreement between these data and the velocities found in man through measurement of reaction times: 40 m/sec for touch, 4.5 m/sec for burning, 16 m/sec for pricking, and about 12 m/sec for pinching.

This finding that there is dissociation of afferent systems for painful excitations of the skin has been shown to be in agreement with numerous other data, some of which were reported by G. H. Bishop and W. L. Landau (*11*); it can be considered to be a definitively established fact (*12*).

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2 January 1959

Due to limitation of space, I shall limit my discussion to the reaction-time studies which are assumed to prove the duality (or even plurality) of cutaneous pain systems.

I have stated (*1*) that none of the studies of reaction time meets the minimum requirements for reliable results. I repeat, none of them do—not excluding the study of Lele, Sinclair, and Weddell (*2*). But the work of Lele *et al.* was technically superior to most, and it did show that, even in studies of the sense of touch (far easier to deal with than pain), variability of results is the rule. The conclusion I draw is that more than ordinary caution is required to demonstrate a reliable difference in reaction time between two areas.

In the study of pain, proper control of stimulus has been a vexing problem. With needle stimuli, even when properly applied, there is a variation in time lag before stimulation because of the appreciable amount of time necessary for the needle to penetrate to its maximum depth (*3*), and because of the varying depth of the receptors. With heat stimuli, the time lag is both greater and more variable because of variation in the thickness and character of the epithelium in different areas of the body (*4*). And the difficulties involved in precise control of heat stimuli are many (see *5*).

The study which Piéron cites as definitely establishing the dissociation of pain systems is his own (*6*). In this study, on one test subject, a needle was used to produce pricking pain, with pressure of 15 g on the temple, 25 g on the wrist, and 25 g on the ankle. As far as one can ascertain from the report, 24 trials were made at each point. There is no information about pretraining on this type of response (and in any event, the learning curve for reaction-time data does not level off until at least the 100th trial) or about the subject's "coherence"—or, indeed, about how much he knew about what the experimenter expected to find. The intensities used are greatly above those of the pain threshold, and a statement that they were approximately equated for the three areas is not convincing, in the absence of experimental data, in view of the great variability in pain threshold of various pain spots (*7*) and of the extreme difficulty of making that type of psychophysical judgment. Further, there is no measure of the significance of the differences in reaction time used to calculate conduction velocities in nerves.

In the same study, burning pain was produced by application of a metal container filled with water at 70°C (or 60°C?) to the forehead and the back of the hand (four trials each). Since this stimulus gave reaction times for the foot which were too long to be "useful," the difference in reaction time between hand and foot was determined by plunging them into a hot (60°C) water bath (11 and 4 trials, respectively). In neither case is the stimulus constant over time, nor does it bear any observable relation to the threshold for heat pain. In the latter case, even the areas vary. Heat stimuli, to be even moderately controlled, must be constantly monitored, and even then changes or differences in blood flow, color of skin, and chemical changes within the tissues (particularly upon repetition) may render the control superficial.

Heat of this order penetrates tissues more slowly than a needle, and the slower reaction times to heat pain are certainly correlated with the time lag between application of the stimulus to the surface of the skin and the stimulation of the underlying receptors. Furthermore, the differences in the epithelium in various regions of the body would lead one to expect a greater time difference in the response to heat of forehead, hand, and foot than in the response of these areas to suprathreshold stimuli produced by a needle.

McKenna (*8*) found that neither surface temperature nor increase in surface temperature is critical for stimulation of pain by heat, but, rather, that the important factor is either the critical temperature at the receptor or the temperature difference between receptor level and deeper fibers. Thus, the depth and thermal characteristics of the epithelium would seem to be important determinants of absolute reaction time, as well as of the differences in reaction time between various regions of the body.

Until a slow pain ("subjective" because perceived) in the absence of the afore-mentioned artifacts can be demonstrated, there exists no body of data to be related to the physiological data regarding cutaneous C-fiber function.

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27 March 1959

Separation of Hydrogen Isotopes by Gas-Solid Chromatography

Abstract. Conditions are described for the chromatographic analysis of mixtures of H_2, HT, and T_2 on a "molecular sieve" column. This technique may find valuable applications in various kinetic investigations.

Isotope effects in gas chromatography have been observed previously (*1*). We have found that this phenomenon can be used to analyze mixtures of H_2, HT, and T_2. Samples were prepared by

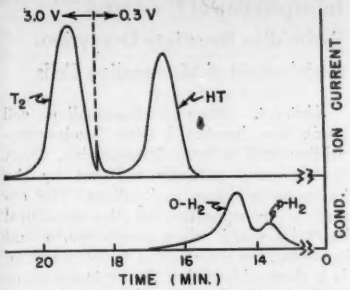

Fig. 1. Separation of ortho- and para- H_2, HT, and T_2 by gas-solid partition chromatography.

sparking mixtures of about 1 percent T_2 in H_2 with a Tesla coil. They were passed through a 6.1-m molecular sieve column with helium carrier gas. The column was kept at −160°C with a bath of liquid methane containing about 10 percent ethane. The gas chromatograph was modified by the addition of a 10-cm³ ionization chamber in series with the thermal conductivity cell (*2*). Both detectors were kept at 30°C. The chemical peaks (thermal conductivity) and radiochemical peaks (ion current) were recorded on synchronized recording potentiometers. The results are depicted in Fig. 1. Hydrogen showed two peaks with relative heights of 3 to 1, corresponding to ortho- and para-hydrogen (*3*). A sample of pure para-hydrogen gave only one peak at retention time of 13.5 minutes. Prolonged treatment of a sample with a Tesla coil increased the HT peak and decreased the T_2 peak. When the sample was placed on activated uranium (*4*), then taken out, the peak identified as T_2 disappeared.

One of the easily controlled variables in the analysis was the flow rate of the carrier gas. In Fig. 2, the heights equivalent to a theoretical plate (H.E.T.P.) for HT and T_2 are plotted against flow rate of carrier gas (*5*). From this figure, it is concluded that a flow rate of about 10 cm/sec gives maximum separation. The number of theoretical plates for HT and T_2 were then 4060 and 4580, respectively.

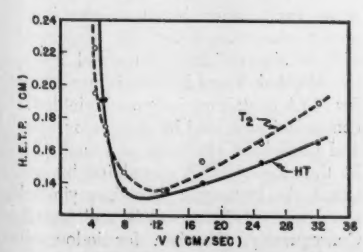

Fig. 2. H.E.T.P. (cm) for HT and T_2 versus flow rate of helium carrier gas (cm/sec).

The results reported here can be utilized for investigating the kinetics of some interesting systems: for example, the radiolysis of $T_2 + H_2$ mixtures and the formation of HT in Wilzbach labeling (*6*).

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Electrophoretic Method for Desalting Amino Acids

Abstract. A solution to be desalted is placed on a paper strip along which an ammonium formate buffer gradient has been established. Application of a potential brings about migration of amino acids to their isoelectric *p*H's and removal of salt ions. The strip is eluted with water, and the eluate is freed of ammonium formate by vacuum sublimation at 40°C.

Salts in amino acid preparations (for example, protein hydrolyzates or tissue extracts, to be analyzed chromatographically) are objectionable (*1, 2*). Several desalting procedures have been developed but, according to Block *et al.* (*1*), not one is completely satisfactory.

The need for a simple general method of desalting micro quantities of amino acids and peptides from protein hydrolyzates led to the development of an electrophoretic procedure that takes advantage of the volatility of ammonium formate [previously exploited in ion-exchange chromatography of amino acids by Hirs *et al.* (*3*)]. The sample to be desalted is subjected to electrophoresis on a paper strip along which a *p*H gradient is established by use of ammonium formate buffer. The amino acids migrate to the region of their isoelectric *p*H at or near the midpoint of the strip, the unwanted salt ions move to the solutions around the electrodes, and ammonium formate is left as the only electrolyte on the strip. After electrophoresis, the strip is eluted with water, and the eluate is vacuum dried at 40°C. The ammonium formate sublimes, and the desalted hydrolyzate remains as a residue.

The method was tested as follows with single-strip Durrum-type paper electrophoresis cells (*1*, p. 511; *4*): A 1- by 10-in. strip of Whatman No. 1 paper, held vertically, was washed by allowing 200 ml of water to flow down through it (as in descending chromatography). The ends of the dried strip were placed in the electrode compartments with ammonium formate buffers of 0.1 ionic strength at *p*H's above and below the isoelectric points of any amino acids present [for example, above 10.8 and below 2.3 if both arginine (*pI* 10.8) and aspartic acid (*pI* 2.3) are present]. The paper was supported at its midpoint by a horizontal glass rod (3 mm in diameter) rubbed with silicone stopcock grease (*1*, p. 512). The sample of solution to be desalted (usually 10 to 30 μl) was applied at the midpoint of the strip, a glass cover was placed over the strip, and the buffer solutions were allowed to migrate up the strip to complete the liquid junction. A potential of about 50 v per cell was applied overnight, the electrode in the low *p*H buffer being positive. After electrophoresis, the ends of the strip were cut off just above the buffer vessels, the strip was allowed to dry at room temperature, and the amino acids were eluted by allowing 20 ml of water to flow down through the vertically suspended strip. The eluate was vacuum-dried for at least 16 hours at 40°C (*5*). The possibility of scaling up the quantity of sample is indicated by the recovery of 0.98 g of glycine from a solution of 1.00 g of glycine in 5 ml of 0.1*M* KCl on a single large sheet of Whatman No. 1 paper in the Spinco model R apparatus.

Figure 1 shows two-dimensional chromatograms of 20-μl samples of amino acid solutions in 1*N* NaCl containing

Table 1. Data on recovery and salt removal for 80 μl of 1 percent DL-phenylalanine in 1*N* NaCl. The values shown in parentheses were obtained before desalting.

Absorbance (at 280 mμ)	Recovery of amino acid (%)*	NaCl (mg)	NaCl remaining (%)*
	Experiment 1		
0.161 (0.137)	95	0.12 (4.68)	1.1
	Experiment 2		
0.170 (0.137)	102	0.08 (4.68)	0.2
	Experiment 3†		
0.031 (0)		0.07 (0)	

* After correction for blank.
† Blank (no sample added to filter paper strip).

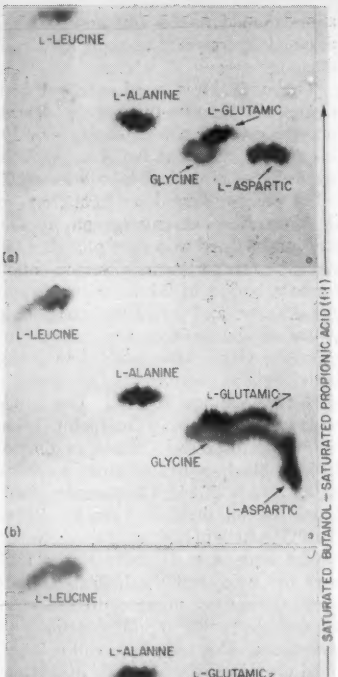

Fig. 1. Chromatograms of an amino acid mixture: (a) water solution, (b) 1*N* NaCl solution, (c) 1*N* NaCl solution followed by desalting.

1.5 mg/ml of each amino acid present. These are typical of results obtained when a variety of amino acids as well as other salts were used, including $CaCl_2$, $MgCl_2$, and KCl. The tailing and overlapping in the presence of NaCl and the improvement effected by the desalting procedure are evident.

To determine the extent of migration on the filter paper and to check the recovery of the amino acids, strips were sprayed with Ninhydrin after electrophoresis and both before and after elution with 20 ml of water. Sprayings before elution (*6*) revealed that the amino acids concentrated rapidly in a band 1 to 2 cm wide and 0 to 3 cm from the point of application, depending on their isoelectric points and the *p*H gradient in the strip. Sprayings after elution did not result in any color development, even on prolonged heating at 105°C, indicating fairly complete removal of both the amino acids and the ammonium formate. In the foregoing, solutions of glycine, glycylglycine, L-alanine, L-glutamic acid, L-cystine, L-methionine, DL-phenylalanine, L-arginine, L-lysine, L-tyrosine, L-tryptophan, and L-valine, were used.

Recovery of DL-phenylalanine and the extent of desalting were also investigated by light absorption and electrical conductance measurements. A typical set of results is shown in Table 1 for experiments in which Whatman No. 1 paper treated with LiOH was used. Because of soluble light-absorbing and conducting material in the paper, corrections with a blank (*7*) were necessary. All absorbances and conductances are for samples diluted to 5 ml with water. The conductances (corrected for solvent) are expressed as milligrams of NaCl. The data show that both the recovery of the amino acid and the removal of salt are essentially complete.

Preliminary experiments with 2′- and 3′-uridylic and 2′- and 3′-cytidylic acids indicate that the procedure can be applied to nucleotides. A strongly acid buffer (for example, 0.1*M* ammonium formate in 50 percent formic acid for uridylic acid) was necessary on the low *p*H side because of the low isoelectric points of these substances (*8*).

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4. A few runs, which proved quite satisfactory, were made with the Spinco model R eight-strip Durrum-type apparatus with Whatman No. 1 paper. With heavier papers, such as 3MM, desalting was not so effective.
5. A laboratory Glass and Instruments Corporation Evapo-Mix evaporator accommodating ten sample tubes was used. The small quantity of ammonium formate present either was completely removed to the cold trap or was condensed as a few hard crystals in the lead-off line between the sample tubes and the trap.
6. If the strip is heated after spraying, color caused by the presence of ammonium formate develops rapidly and obscures the amino acid color. Therefore, the strips were allowed to develop at room temperature.
7. The paper could be temporarily freed of absorbing and conducting material by thorough washing with water or with dilute acid or alkali followed by water. However, the offending material would again appear in reduced amounts in eluates obtained a few hours later. Finally, this effect was eliminated by heating the strips in 1 percent LiOH, at just below boiling temperature overnight, and washing thoroughly with water, although this treatment did not reduce the blank correction to zero (Table 1). Since it was found that the chromatograms (Fig. 1) were not significantly improved by the LiOH treatment, the matter was not pursued further. Evidently a much more thorough treatment, possibly one such as that developed by G. E. Connell, G. H. Dixon, and C. S. Hanes [*Can. J. Biochem. and Physiol.* 33, 416 (1955)], which included a 22-day elution with LiOH, would be necessary to remove all soluble conducting and light absorbing matter.
8. The work described in this report originated in discussions with Dr. N. G. Anderson of the Biology Division, Oak Ridge National Laboratory. I wish to thank Mr. R. E. Canning for running the chromatograms.
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26 January 1959

Incorporation of Unnatural Pyrimidine Bases into Deoxyribonucleic Acid of Mammalian Cells

Abstract. When a mammalian cell strain was incubated with 5-iododeoxyuridine and 5-bromodeoxyuridine, DNA thymine was partially replaced by the halogen-containing pyrimidines. The extent of incorporation of the unnatural bases increased when amethopterin and hypoxanthine were added to the medium. It is thus evident that the replacement of DNA thymine by selected structural analogs, a phenomenon previously reported for bacterial systems, is applicable to cells of higher organisms.

Following preliminary observations of Weygand *et al.* (*1*), Zamenhof *et al*, and Dunn and Smith (*2–5*) have demonstrated the introduction of 5-chloro, 5-bromo, and 5-iodouracil into the deoxyribonucleic acid (DNA) of several bacterial strains. These pyrimidines are considered structural analogs of thymine for which the Van der Waals' radii of the halogen atoms are approximately equal to the radius of the methyl group (*5, 6*). The extensive incorporation (reported in this paper) of 5-bromouracil and 5-iodouracil into the DNA of a mammalian cell strain demonstrates that this phenomenon can be extended to cells of higher organisms.

In vitro experiments in our laboratory had shown that 5-bromodeoxyuridine severely depressed the incorporation of labeled thymidine into the DNA of H.S. No. 1 human tumor transplant slices (*7*). However, a search for incorporation of bromouracil into the DNA of this tissue slice system had yielded negative results.

Cells (H.Ep. No. 1) derived from a human cervical carcinoma (*8*) were grown in large Blake bottles with Eagle's medium (*9*) plus 20 percent horse serum. After cell growth on glass had been established, 5-iododeoxyuridine (*10*), 5-bromodeoxyuridine, hypoxanthine, and amethopterin were added to the culture medium as indicated in Table 1. After approximately 3 days the cells were washed with saline and harvested with 0.05 percent trypsin (*11*). The DNA bases were obtained by a procedure previously described (*12*) and separated from each other by two-dimensional paper chromatography. In agreement with the observations of Dunn and Smith, the Marshak-Vogel hydrolytic procedure for DNA containing iodouracil yielded a compound identified by chromatography and ultraviolet spectrum as uracil (*3*). In the case of DNA containing bromouracil, the hydrolytic procedure yielded a mixture of bromouracil and uracil. Consequently, the data for iodouracil and bromouracil shown in Table 1 are based on the yield of these hydrolysis products.

Table 1. Ratio of halogen-containing bases to thymine in the DNA of H. Ep. No. 1 cells.

Compound	Molar concentration in culture medium	
	A	B
Experiment No. 1		
5-Iododeoxyuridine	1.4×10^{-4}	1.4×10^{-4}
Hypoxanthine		3.6×10^{-5}
Amethopterin		1.0×10^{-7}
Ratio in DNA: I-containing base/thymine	0.30	0.61
Experiment No. 2		
5-Bromodeoxyuridine	1.7×10^{-4}	1.7×10^{-4}
Hypoxanthine		3.6×10^{-5}
Amethopterin	1.0×10^{-7}	1.0×10^{-7}
Ratio in DNA: Br-containing base/thymine	0.76	0.84

In order to demonstrate directly the incorporation of the iodouracil moiety, cells were harvested from a medium containing 5-iododeoxyuridine labeled with I^{131}. The residual solution following extraction of the defatted cells with 10 percent sodium chloride, protein removal by chloroform gel formation (*3, 13*), and subsequent dialysis was analyzed by paper chromatographic methods and scintillation counting. The radioactivity in a compound chromatographically identical with 5-iododeoxyuridine could be recovered only after treatment of the above solution with deoxyribonuclease followed by treatment with snake-venom phosphoesterases (*3*).

Fig. 1. Autoradiograph of H. Ep. No. 1 cell after incubation in tritium-labeled 5-bromodeoxyuridine for 3 days (in the presence of amethopterin and hypoxanthine) followed by incubation in unlabeled medium for 2 days. Localization of reduced silver grains over the nucleus can be observed. Kodak AR 10 stripping film and MacNeal Tetrachrome stain were employed.

The iodouracil moiety can be incorporated into the DNA of these cells even in the absence of amethopterin, which acts to depress *de novo* thymine synthesis (Table 1, expt. 1A). In experiments 1B and 2B, amethopterin was added to enhance the utilization of the exogenous thymine analogs, while hypoxanthine provided a source of preformed purine moiety. The results of experiment 2 indicate that the addition of hypoxanthine in the presence of amethopterin did not appreciably change the incorporation of the bromouracil moiety. These results may be related to Hakala's observation that 5-bromodeoxyuridine can support HeLa cell growth in a culture medium containing amethopterin, glycine, and hypoxanthine or adenine (*14*).

The molar ratio of DNA thymine to adenine is close to 1.0 for cells grown in normal medium, while in the experiments listed in Table 1 the sum of thymine plus halogen-containing pyrimidine more closely fits this relationship. These results suggest that the halogen-containing pyrimidines partially replace thymine, as has been observed in the bacterial systems studied (*2–5*).

The nuclear localization of the halogen-containing pyrimidines was confirmed by autoradiographic studies in which 5-bromodeoxyuridine labeled with tritium (*15*) and 5-iododeoxyuridine labeled with I^{131} were used. The cell culture conditions were equivalent to experiments 1B and 2B of Table 1. An autoradiograph made with tritium-labeled 5-bromodeoxyuridine is shown in Fig. 1 (*16*).

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31 December 1958

Low-Level X-ray Damage to Amphibian Erythrocytes

Abstract. In vitro x-irradiation of frog and *Amphiuma* erythrocytes caused cytophysiological damage to part of the cell population. There was a significant decrease in the percentage of normal cells and some hemolysis. Changes were also observed in the electrical capacitance and potassium-42 uptake of irradiated erythrocytes.

There is considerable evidence that low-level ionizing radiation causes significant changes in populations of dividing cells (*1*). Until recently there has been little information available on the effect of small doses of x-irradiation on the cytophysiology of nondividing (postmitotic) cells (*2*). I chose nucleated amphibian erythrocytes as a biological representative of the postmitotic cell type because of their large size and relatively high metabolic rate and because large numbers of intact cells were easily obtained. Although many millions of cells were observed in these studies, I did not find dividing erythrocytes in the blood of the species studied (*3*).

Curarized animals were bled from the heart (bullfrog) or tail vein (*Amphiuma*) (*4*), and the heparinized blood was washed in physiological saline (*5*). Pooled blood samples were kept at approximately 5°C during all procedures of preparation and were exposed to room temperature (22° to 25°C) only during the experiment. Cell suspensions (hematocrit 33) were divided into control (unirradiated) and irradiated aliquots and poured into Lucite dishes 3½ in. in diameter to a depth of 2 to 3 mm. Irradiations were carried out with a 100-kv (peak) x-ray tube operated at 15 ma (*6*). Because of variation in the degree of response produced by x-irradiation, all experimental procedures were either carried out on the same blood samples or repeated on a sufficient number of samples to obtain averages representative of the cell population. Except for the ir-

radiation, exactly the same procedures were applied to both the control and experimental samples.

Phase-microscope studies of unirradiated and irradiated erythrocytes (Fig. 1) indicated that x-irradiation caused an increase in the number of irregularly shaped cells (cells with folded and ruffled membranes) and of irregular nuclei. Immediately following 50- and 100-r x-irradiation, some hemolysis was observed, but none was observed following 10-r x-irradiation. Irradiated erythrocyte suspensions showed further hemolysis after they were transferred to conical tubes and centrifuged. The supernatant was carefully replaced with cold isotonic saline, and the cells were stored at 5°C for 24 and 48 hours, respectively. Further hemolysis was observed only in the erythrocyte suspensions irradiated at 100 r with little or none in the aliquots irradiated at 10 and 50 r. There was apparently a rapid hemolysis of damaged, fragile, and aged erythrocytes; this left a relatively hemolysis-resistant population of cells after 24 hours. An analogous result was reported by Alpen *et al.* (7), who, after 500-r whole-body x-irradiation of rats, found an increased resistance to osmotic hemolysis after 24 hours.

In an effort to follow the course of hemolysis, cell counts of relatively undisturbed erythrocyte suspensions were carried out. There was an increase in the number (per 1000 cells counted) of irregularly shaped and cytologically abnormal cells following 50-r x-irradiation of frog and *Amphiuma* red cells. Phase-microscope cell counts after 100-r irradiation indicated a 10-percent increase in the percentage of damaged cells in the irradiated suspensions as compared to the controls. No significant change in the percentage of damaged cells was found after 24 and 48 hours of storage (at 5°C) of irradiated erythrocytes in fresh (unirradiated) physiological saline. The decrease in the percentage of cytologically normal cells is apparently an indication of irreversible cellular damage due to radiation.

The effect of x-rays on the red-cell envelope was investigated by means of radioisotope and electrical techniques. The capacitance of paired aliquots of unirradiated and 100-r x-irradiated frog erythrocytes at 28°C was determined. Measurements of washed packed cells were carried out in a Lucite cell with the two end walls made of 1-cm² platinum plates placed 0.3 cm apart. Observations were made in accordance with Fricke's theoretical and experimental method (8), over a frequency range of 10 to 100 kcy/sec, by means of an alternating-current Wheatstone bridge, with an oscilloscope as a detector. The irradiated cells showed a consistent elevation in capacitance, as compared to the unirradiated cells, over the entire frequency range studied (Fig. 2). This may be interpreted as physical evidence of changes in cell geometry or in membrane ultrastructure, or in both.

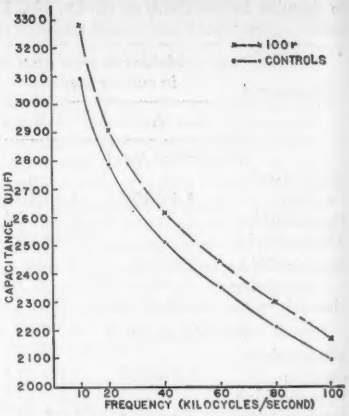

Fig. 2. Capacitance (in micromicrofarads) of paired aliquots of unirradiated and 100-r x-irradiated frog erythrocytes at 28°C.

Additional evidence for cell membrane changes was shown by increased $K_2{}^{42}CO_3$ uptake immediately after irradiation at 100 r. This was followed by a loss in K^{42} after 90 minutes in both frog and *Amphiuma* cells. There were three capacitance experiments which indicated greater differences between control and irradiated cells ½ hour after radiation treatment than were apparent 1½ hours after irradiation. This suggests that some of the changes observed are reversible in nature and follow trends similar to those found in respiration studies of the same cells (2).

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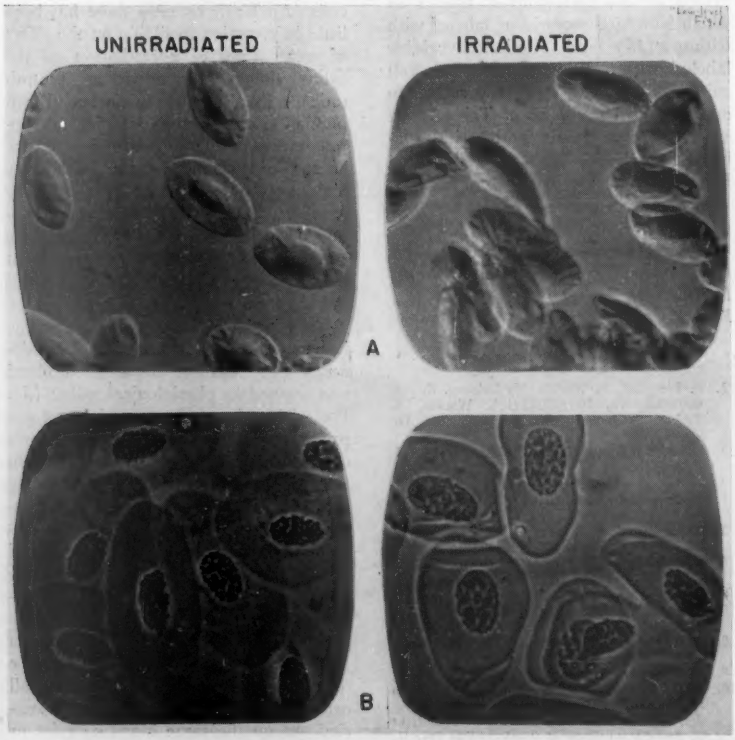

Fig. 1. Phase-microscope pictures of *Amphiuma* erythrocytes. (A) Living cells; (B) fixed and Feulgen-stained cells. Note ruffled and folded cell membranes and irregular cell and nuclear outlines.

References and Notes

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3. This investigation was supported by the Research and Development Division, Office of the Surgeon General, Department of the Army under contract No. DA-49-007-MD293.

4. *Amphiuma tridactylum* (congo eel) and *Rana catesbeiana* (bullfrog) erythrocytes were mainly studied. Some observations were made on the blood of *Necturus maculosus* (mud puppy) and *Rana pipiens* (leopard frog).

5. M. A. Lessler, *Anat. Record* 120, 782 (1954).

6. The inherent filtration was 1 mm of Al at a target distance of 30 cm. The dose rate, meas-

ured in air with a Victoreen roentgenometer, was approximately 140 r/min.

7. E. L. Alpen, J. A. Alexander, A. K. Davis, *Am. J. Physiol.* 179, 541 (1954).
8. H. Fricke, *J. Appl. Phys.* 1, 106 (1931). I wish to thank Dr. George Fukuyama and Dr. Ralph Stacy for carrying out these measurements.

* Currently on fellowship (until September 1959) at the department of physiology, University of Michigan.

24 November 1958

Phenylpyruvic Acid as a Possible Precursor of *o*-Hydroxyphenylacetic Acid in Man

Abstract. The oral administration of phenylpyruvic acid to human subjects results in increased urinary excretion of *o*-hydroxyphenylacetic acid. This demonstrates that phenylpyruvic acid may act as a precursor for *o*-hydroxy derivatives of phenylalanine and suggests that the formation of *o*-tyrosine is not necessary to account for the excretion of *o*-hydroxyphenylacetic acid in phenylketonuria.

o-Hydroxyphenylacetic acid (*o*-HPAA) has been found to be the major hydroxy metabolite of phenylalanine excreted in the urine of patients with the hereditary metabolic disorder known as phenylketonuria (*1–3*). Such a conversion could theoretically occur by the *o*-hydroxylation of phenylalanine, phenylpyruvic acid, or phenylacetic acid. Armstrong and Shaw (*4*) found that the excretion of *o*-HPAA followed the oral administration of *o*-tyrosine in man, and postulated that *o*-tyrosine was a probable intermediate in the formation of *o*-HPAA in phenylketonurics. Mitoma *et al.* (*5*) suggested that the overproduction of *o*-tyramine, the decarboxylation product of *o*-tyrosine, was perhaps responsible for the mental defect in phenylketonuria. The presence of *o*-tyrosine or *o*-tyramine has not as yet been demonstrated in the tissues of normal or phenylketonuric individuals. It has been reported, however, that beef adrenals normally contain free *o*-tyrosine (*6*), and it is possible that the normal excretion of *o*-HPAA in man could originate from such a source.

When Berry *et al.* (*7*) applied phenylalanine tolerance tests (*8*) to individuals heterozygous for phenylketonuria (0.1 g of L-phenylalanine per kilogram of body weight), they found that *o*-HPAA but not phenylpyruvic acid was excreted in the urine in increased amounts. Cullen and Knox (*9*) recently confirmed these findings and also showed that a dose of at least 0.13 g of L-phenylalanine per kilogram is usually required before any increased *o*-HPAA can be detected in the urine of normal subjects.

In the course of experiments in this laboratory (*10*), it was found that ingestion of the D-isomer of phenylalanine in man in amounts as low as 0.015 g/kg regularly results in the urinary excretion of phenylpyruvic acid and of increased amounts of *o*-HPAA. This raised the question whether D-phenylalanine or one of its metabolites might be the substrate for *o*-hydroxylation.

In order to test for the possible *o*-hydroxylation of phenylpyruvic acid or its metabolites, the sodium salt of phenylpyruvic acid (Nutritional Biochemicals Corp.) was orally administered to three normal, adult male subjects. Each urine sample following the ingestion of phenylpyruvic acid was immediately assayed for phenylpyruvic acid by a modification of the procedure of Berry and Woolf (*11*), and the collection of urine was continued until no further phenylpyruvic acid could be detected. The individual urine samples in which phenylpyruvic acid was present were then pooled and assayed for *o*-HPAA by a modification of the paper-chromatography technique of Armstrong *et al.* (*2, 12*) in which the chromatogram was developed with 2,6-dichloroquinone chlorimide.

The results (Table 1) show that the ingestion of phenylpyruvic acid causes an increased excretion of *o*-HPAA and indicates that phenylpyruvic acid may be a precursor for *o*-HPAA. However, since no isotope study was carried out with labeled phenylpyruvic acid, the possibility remains that the administration of phenylpyruvic acid might be indirectly increasing the excretion of *o*-HPAA.

Because the evidence presented here shows that the ingestion of phenylpyruvic acid can cause an increased urinary excretion of *o*-HPAA, it is not necessary to assume an increased production of *o*-tyrosine in phenylketonuria in order to account for the increase of *o*-hydroxy derivatives of phenylalanine (*13*).

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Table 1. Urinary excretion of phenylpyruvic acid (PPA) and *o*-hydroxyphenylacetic acid (*o*-HPAA) following the oral administration of sodium phenylpyruvic acid.

PPA ingested (mmole)	Total PPA excreted (μmole)	Collection time (hr) (*X*)	*o*-HPAA excreted (μmole/24 hr) (control)* (*Y*)	Total *o*-HPAA excreted during *X* (μmole) (*Z*)	*Z* less estimated normal excretion of *o*-HPAA during *X* (μmole) [(*Z* − *XY*)/24]
			Subject A		
0			2.6		
2.5	185	3.0		8.5	8.2
5.0	711	6.5		42	41
			Subject B		
0			5.0		
5.0	598	4.5		19	18
			Subject C		
0			10.6		
5.0	581	7.0		51	48

* The normal daily excretion of *o*-HPAA for seven subjects, including subjects A, B, and C, ranged from 2.0 to 10.6 μmole (mean, 5.6 μmole).

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7. H. Berry, B. Sutherland, G. M. Guest, *Am. J. Human Genet.* 9, 310 (1957).
8. D. Y.-Y. Hsia, K. W. Driscoll, W. Troll, W. E. Knox, *Nature* 178, 1239 (1956).
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10. A detailed account of these experiments on D-phenylalanine metabolism is in preparation.
11. J. P. Berry and L. I. Woolf, *Nature* 169, 202 (1952).
12. The *o*-hydroxyphenylacetic acid used as a standard in this study was kindly supplied by Chozo Mitoma of the National Institutes of Health.
13. This investigation was supported in part by research grant A-830 from the National Institute of Arthritis and Metabolic Diseases.

12 February 1959

Meetings

Radiology

The American College of Radiology is a national association of physicians specializing in radiology. The college serves the patient through the advancement of the science of radiology. It has three main purposes. One of these is to improve the distribution, quality, and availability of radiological service to the sick through the study and interpretation of socioeconomic factors as they affect medicine and health. To that end, the commissions, committees, and staff of the college study the economic and social aspects of radiologic practice. Facts thus established result in principles which the college promulgates regarding the relationship of radiologists to their fellow physicians, to hospitals, to health agencies, and to the public.

The second broad purpose is to encourage the development of improved standards and facilities for postgraduate education in radiology. To further this objective, the Annual Conference of Teachers of Radiology was established. At this conference—now held at the time of the annual meeting of the college, in February—pedagogical subjects of concern to teachers of residents in radiology are discussed. This annual teachers' conference, under the direction of the college's commission on education, aids in maintaining high standards of education in radiology.

The college was also instrumental in establishing the section on radiology in the American Medical Association.

Funds are donated anually to the American Registry of Radiologic Pathology in the Armed Forces Institute of Pathology, Washington, D.C., to assist in providing fellowships for residents in radiology who desire further training in pathology. The college also provides consultants for the registry.

The third purpose of the American College of Radiology is to acquaint the medical profession and the public with achievements and developments in radiology and thus encourage progress in this specialty.

Membership in the college is in itself an indication of professional achievement. Only those physicians who are diplomates of the American Board of Radiology or who hold the certificate in radiology of the Royal College of Physicians and Surgeons of Canada are eligible for membership.

Fellows are elected from the membership in acknowledgment of contributions to radiology. Periodically the college awards a gold medal to outstanding physicians "for distinguished and extraordinary service to the American College of Radiology and the profession for which it stands."

The board of chancellors and the various commissions and committees are organized to carry out the projects and programs of the college and to give direction, service, and guidance to college members on request. The board of chancellors is the executive body and governing board of the college and is composed of 12 chancellors, who serve 4-year terms. All are fellows of the college. Eight are selected from the fellowship at large, and one each is nominated by the Radiological Society of North America, the American Roentgen Ray Society, the American Radium Society, and the Canadian Association of Radiologists.

Between meetings of the board of chancellors the activities of the college are directed by an executive committee, composed of the chairman of the board, two chancellors appointed by the chairman and approved by the board, and the president of the college as an ex officio member as is the secretary-treasurer.

The present officers of the college are as follows: president, Lawrence Reynolds (Detroit Mich.); vice president, Charles M. Gray (Tampa, Fla.); chairman of the board of chancellors, Earl E. Barth (Chicago); secretary-treasurer, Fay H. Squire (Chicago); and executive director, William C. Stronach.

One of the most important current projects of the American College of Radiology is an educational program for physicians, outlined in a recent statement.

"The American College of Radiology will cooperate with all efforts to encourage medical authorities of this country to initiate a vigorous movement to reduce radiation exposure from x-rays to the lowest limit consistent with medical wisdom, and. . . to assure that proper safeguards always be taken to minimize the radiation dose to reproductive cells. . . . Appropriate training and experience must be insisted upon for all users of radiation. For all, adequate stress must be placed on protection and safety aspects of the use of radiations in human beings. . . . Certain it is that we all desire to keep the dose of radiation to its lowest level to the population that is well. The dose of radiation to those who are ill and require either studies or treatment with radiation should also be kept as low as possible, but here the conditions for judgment are different. In this case, we give as little radiation as possible in order to achieve the desired end of proper diagnosis or treatment; but when, in a careful radiologist's judgment, an individual patient requires a dose exceeding 10 r or any other arbitrary figure, his medical judgment must prevail. . . . It should be emphasized that genetic considerations do not apply to patients who are past the reproductive period. . . .

"The National Committee on Radiation Protection and the International Commission on Radiation Protection have for many years formulated the standards for the protection of patients, the public and occupational personnel engaged in medical diagnostic procedures. It is necessary that the entire medical profession be acquainted with their recommendations. . . . This means that there is a problem of dissemination of this information to everyone who is engaged in the healing arts."

Information is being disseminated in the following ways.

1) Lectures, symposia, and panel discussions on these subjects are presented at meetings of local, state, and national medical organizations. These discussions are conducted by experts in radiation physics, radiobiology, genetics, and radiology.

2) The text of such discussions is published in appropriate medical journals, and thousands of reprints are distributed to physicians who do not subscribe to these journals.

3) The college has prepared a handbook, *A Practical Manual on the Medical and Dental Use of X-Rays with Control of Radiation Hazards,* which it has distributed to 175,000 physicians in the United States. This manual contains all of the basic information on the problems brought out in the report of the National Academy of Sciences and in the United Nations report, together with practical, clinical recommendations. The manual is now being translated into Spanish and Portuguese for distribution in Latin America.

4) The college has prepared sets of colored slides illustrating ways to control the hazards of radiological examinations. These slides are available to any physician who requests them. Several hundred sets are now in use.

5) A "protection kit" has been de-

signed by the college. It includes reprints of important articles and material designed to help radiologists and other physicians give talks on radiation protection before medical groups. More than 1000 kits have been distributed.

6) A 16-millimeter documentary motion-picture film dealing with radiation protection is being prepared for use of the medical profession. This is being financed in part by the Rockefeller Foundation.

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International Botanical Congress

The ninth International Botanical Congress will be held in Montreal, 19–29 August, at the University of Montreal, McGill University, and Sir George Williams College. The first session of the International Botanical Congress took place in Brussels in 1864. It has been held only once before on this continent, in the United States. This will be the first time it has been held in Canada. About 6000 delegates from 72 countries are expected to attend.

The program of the scientific sessions will be conducted in 16 sections and will deal with all aspects of botany in its broadest sense, including plant production, breeding, and protection, and their implications for agriculture and forestry. Some 400 scientists, representing all sections of the program, have been invited to present papers, participate in symposia, and deliver public lectures. About 2000 contributed or voluntary papers will also be given.

An extensive series of field trips constitute an important part of the congress. Seventeen precongress field trips and seven postcongress field trips have been organized, covering the period 20 July to 14 September. These trips will take foreign scientists to all parts of Canada, from coast to coast, and to the subarctic. Probably about 2000 delegates will participate.

During the period of the meetings in Montreal, commercial firms will be given the opportunity of exhibiting in the winter stadium of McGill University, where nearly 90 booths will be provided. Canadian government departments and research institutions will have displays at various places on the campuses.

The estimated cost for organization, publications, and so forth will be about $225,000. Of this sum about $75,000 will be obtained from government sources ($50,000 has already been provided by the federal government), $75,000 will be secured from the delegates, and it is hoped that $75,000 will be forthcoming from Canadian industrial interests.

Free Radical Stabilization

The fourth International Symposium on Free Radical Stabilization will be held at the National Bureau of Standards, 31 August to 2 September. Emphasis will be placed on the properties of solids containing trapped radicals and on the chemical and physical interactions involving trapped radicals at low temperatures.

Activities tentatively scheduled for the first day of the symposium include a discussion of the organization and aims of the NBS free-radicals program, a session on low-temperature chemistry, and a banquet in the evening. On the following day, the discussions will be concerned with methods of production of trapped radicals and physical properties of radical-trapping solids and with the identity and concentration of trapped radicals. The evening activities will include a round-table discussion of future trends in free-radical stabilization. The final session of the symposium, on the interaction of free radicals with solids, will be held the morning of 2 September. That afternoon, tours of the laboratories of the bureau's Free Radicals Program will be conducted.

In addition to the conducted tours, informal visits to the free radicals laboratories may be arranged for the two days immediately following the symposium. These visits should be planned in advance by writing the National Bureau of Standards.

Although the program of presented papers is for the most part already complete, time has been set aside in the various discussion periods for brief reports. These short communications will be listed in the program but need not be submitted in manuscript form. Notification of the nature of a proposed communication should be made *before 1 August*.

The NBS has arranged for accommodations at Dunbarton College, which is located within a few minutes' walking distance of the NBS. Dormitory facilities at $5 (single) or $3.50 (double or multiple) per night are available from 30 August to 5 September. Further information can be obtained by writing Dr. A. M. Bass, National Bureau of Standards, Washington 25, D.C.

Reactor Technology

Oak Ridge National Laboratory has announced that the third Conference on Analytical Chemistry in Nuclear Reactor Technology will be held at Gatlinburg, Tenn., on 26–28 October. The general theme of this conference, "Analysis of Reactor Materials Following the Operation of Nuclear Reactors," complements prior meetings, which dealt

with (i) advances in the chemical analysis of important reactor materials, and (ii) the role of analytical chemistry in the startup and operation of nuclear reactors.

The subjects which will be emphasized at this conference are chemical analysis as related to the estimation of corrosion and erosion rates; reprocessing of fuels and blanket materials; and the analytical chemistry of fission product mixtures, of plutonium, and of the transplutonic elements.

The contribution of papers pertaining to these or closely related subjects is solicited. Presentations on new developments or improvements in methods of chemical analysis, including advances in instrumentation, are especially invited, although review papers and those involving pertinent theoretical discussions may well prove to be of equal interest and should be submitted for consideration.

To facilitate the completion and distribution of the program well in advance of the conference, speakers are requested to submit abstracts of about 500 words *not later than 1 August* and to indicate the time required for their presentation, not to exceed 30 minutes. The proceedings of the conference will be published.

All communications about the conference, including the submission of manuscripts and abstracts, should be directed to: C. D. Susano, Oak Ridge National Laboratory, P. O. Box Y, Oak Ridge, Tenn. Inquiries with respect to accommodations, or requests for reservations, should be addressed to: Mr. Tom Woods, Manager, Mountain View Hotel, Gatlinburg, Tenn.

Forthcoming Events

July

1–3. Hydraulics, annual conf., Fort Collins, Colo. (W. H. Wisely, American Soc. of Civil Engineers, 33 W. 39 St., New York 18.)

1–4. British Tuberculosis Assoc., annual (closed), Cambridge, England. (BTA, 59, Portland Pl., London, W.1, England.)

1–5. International Radio and Electronics Conv., Cambridge, England. (British Institution of Radio Engineers, 9, Bedford Sq., London, W.C.1, England.)

2. Radiation and Ageing, Ciba Foundation 3rd annual lecture on ageing, London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

3–5. International Union of the Medical Press, 4th cong., Cologne, Germany. (Dr. Stockhausen, Secretary of Bundesaerztekammer, Cologne.)

4–9. American Soc. of X-ray Technicians, Denver, Colo. (Miss G. J. Eilert, 16 14 St., Fond du Lac, Wis.)

6. Shortening of Lifespan of Mammals Following Irradiation, research forum, London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

6–8. Cell Structure and Function, 10th annual symp., Ann Arbor, Mich. (J. M. Allen, Dept. of Zoology, Univ. of Michigan, Ann Arbor.)

6–8. Oxford Ophthalmological Cong., Oxford, England. (I. Fraser, 21, Degpole, Shrewsbury, Shropshire, England.)

6–8. School and University Health, 3rd intern. cong., Paris, France. (Comité d'Organisation du Congrès d'Hygiene Scolaire et Universitaire, 13, rue du Four, Paris 6e.)

6–11. Seed Testing, intern. conv., Oslo, Norway. (Intern. Seed Testing Association, Danish State Seed Testing Station, Thorvaldsensvej, 57, Copenhagen V, Denmark.)

6–12. Chagas' Disease, intern. cong., Rio de Janeiro, Brazil. (C. Chagas, Instituto de Biofisica, avenida Pasteur 458, Rio de Janeiro.)

7–10. Royal Medico-Psychological Assoc., annual meeting, Glasgow, Scotland. (RM-PA, 11, Chandos Street, London, W.1, England.)

12–17. American Waterworks Assoc., annual conv., San Francisco, Calif. (H. E. Jordan, AWA, 521 Fifth Ave., New York 17.)

13–17. National Assoc. of Power Engineers, natl. conv., Boston, Mass. (A. F. Thompson, Secretary, NAPE, 176 W. Adams St., Chicago, Ill.)

13–17. Plastic Surgery, 26th intern. cong., London, England. (D. Matthews, Organizing Secretary, Intern. Cong. on Plastic Surgery, c/o Inst. of Child Health, Hospital for Sick Children, Great Ormond St., London, W.1.)

13–17. Standardization, intern. (council meeting), Geneva, Switzerland. (ISO, 1–3, rue Varembe, Geneva.)

15. American Soc. of Facial Plastic Surgery, New York, N.Y. (S. M. Bloom, 123 E. 83 St., New York 28).

15–17. Fluorine Chemistry, symp., Birmingham, England. (Chemical Soc. of London, Burlington House, Piccadilly, London, W.1.)

15–17. Shaft Sinking and Tunnelling, symp., Olympia, London, England. (Institution of Mining Engineers, 3, Grosvenor Crescent, London, S.W.1.)

15–18. British Assoc. of Urological Surgeons (members and guests), Glasgow, Scotland. (Joint Secretariat, 45, Lincoln's Inn Fields, London, W.C.2, England.)

15–18. British Cong. of Obstetrics and Gynaecology, 15th, Cardiff, Wales. (BCOG, Maternity Hospital, Glossop Terrace, Cardiff.)

15–24. British Medical Assoc., Edinburgh, Scotland. (BMA, Tavistock, Sq., London, W.C.1, England.)

16–24. Canadian Medical Assoc., 92nd annual meeting in conjunction with the British Medical Assoc., Edinburgh, Scotland. (A. D. Kelly, CMA, 150 St. George St., Toronto 5, Ontario, Canada.)

17. High Energy Nuclear Physics, 9th annual intern. conf. (Intern. Union of Pure and Applied Physics, Moscow, U.S.S.R.). (R. E. Marshak, Univ. of Rochester, Rochester, N.Y.)

19–24. American Crystallographic Assoc., Ithaca, N.Y. (J. Waser, Rice Inst., Houston 5, Tex.)

19–25. Pediatrics, 9th intern. cong., Montreal, Canada. (R. L. Denton, P.O. Box 215, Westmount, Montreal 6.)

20–26. Radiation and Atmospheric Ozone, joint symp., by Intern. Union of Geodesy and Geophysics and World Meteorological Organization, Oxford, England. (WMO, Campagne Rigot, 1, avenue de la Paix, Geneva, Switzerland.)

22–23. Rocky Mountain Cancer Conf., Denver, Colo. (N. Paul Isbell, 835 Republic Bldg., Denver 2.)

23–30. Radiology, 9th intern. cong., Munich, Germany. (Sekretariat des 9 Internationalen Kongresses für Radiologie, Reitmorstrasse 29, Munich 22.)

26–30. International Psychoanalytical Assoc., Copenhagen, Denmark. (Miss P. King, 37 Albion St., London, W.2, England.)

27–4. International Federation of Translators, Bad Godesberg, Germany. (Dritter Internationaler FIT-Kongress, Kongress Sekretariat, Bundesverband der Dolmetscher und Übersetzer e. V. (BDÜ) Hausdorfstrasse 2, Bonn, Germany.)

30–31. Computers and Data Processing, 6th annual symp., Estes Park, Colo. (W. H. Eichelberger, Denver Research Inst., Univ. of Denver, Denver 10, Colo.)

(See issue of 15 May for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable, and it reflects the claims of the manufacturer or other source. Neither Science *nor the writer assumes responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 1566.*

■ PHOTOJUNCTION CELL type 7223 is a germanium p-n alloy junction type with S-14 response. The cells are of head-on design with shell diameter 0.08 in. and minimum window diameter 0.06 in. Wavelength of maximum response is 15,000 A. Dark current with polarizing voltage of 2.5 v is 14 μa. Sensitivity at 15,000 A and 2.5 v polarization is 0.68 μa/w m². Maximum polarizing voltage is 50. (Radio Corporation of America, Dept. 828)

■ DELAY LINE has band width up to 1000 Mcy/sec. Six models have characteristic impedance of 50, 75, and 93 ohm. Total delays are 1.11 and 11.1 μsec and 47.5 mμsec. Rise time is less than 4 percent of delay at any point. Accuracy of better than 0.5 percent with correction factors is claimed. Maximum input voltage is over 500 v. (AD-YU Electronics Laboratory, Inc., Dept. 837)

■ RADIOISOTOPE LABORATORY, for use in training for analytical and industrial applications of radioactive isotopes, incorporates all equipment needed for measuring radioactive disintegrations. Typical laboratory includes a shielded Geiger-Mueller counter, sample changer, radiation absorber, scaler, sample preparation equipment, radioactivity standards, and radiation source. (Nuclear-Chicago Corp., Dept. 838)

■ SERVO AMPLIFIER, designed to operate in a 60-cy/sec servo system, obtains its input from a synchro control transformer or similar source and drives a 20-w servomotor. Input voltage for full 115-v r.m.s. output is 2.0. Input impedance is 20,000 ohm, output impedance 750 + j250 ohm. The amplifier will operate from −55° to +55°C at full ratings. (DI/AN Controls, Inc., Dept. 839)

■ INFRARED INCINERATOR permits ashing of small amounts of organic materials. Heating is provided by focusing rays from an infrared lamp onto a crucible supported at the focal point of a gold-plated parabolic reflector. Operation is on 110 v a-c or d-c. (National Instrument Co., Dept. 850)

■ MAGNET, for removal of ferromagnetic particles from the eye, is said to exert an attractive force over 100 times the weight of the particles. A special cobalt-iron with high saturation flux density is used for the magnetic core. The magnet provides a clear field of approach out-

side a 120 deg cone angle with its apex at the pole tip. Weight is 15 lb. (Metropolitan-Vickers Electrical Co., Dept. 847)

■ REFRIGERATED CENTRIFUGE attains 40,000 *g* in its eight-place, 50-ml head and 26,000 *g* in a six-place, 25-ml head. Temperature is kept constant to ± 1°C by a fin-coiled 1-hp evaporator and a combination of plastic-foam and fibreglas insulation. An electric tachometer indicates rotational speed. (International Equipment Co., Dept. 849)

■ NITROGEN GENERATOR produces nitrogen with any hydrogen content between 0.25 and 25 percent. The process draws nitrogen from both air and ammonia. The process is exothermic and the platinum catalyst used is said to have indefinite life. Generator capacities range from 50 to 10,000 ft³/hr. Operation requires lines for water, air, and ammonia, and 110-v power. (Baker and Co., Dept. 842)

■ PROXIMITY DETECTOR is sensitive to metallic objects over a range of distance adjustable between 0.001 and 0.1 in. Output for open circuit is a change from 2 v to 0 v when metal approaches. Output impedance is 750 ohm. Response time permits counting at rate up to 7200 per minute. Models are available for magnetic and for nonmagnetic metals. (Parametrics, Dept. 844)

■ CORROSION TEST CABINETS provide chambers measuring 96 by 48 by 48 in. Construction material is stainless steel or epoxy-lined mild steel. The chamber is heated by water jackets on all four sides and bottom to temperatures up to 50°F. Temperature is controlled to ±½°F. Counter-weighted lid has a 23-by-17-in. window. (G. S. Equipment Co., Dept. 859)

■ IRRADIATION SERVICES are offered with outputs of two electron accelerator units. The smaller of the two produces 1 Mev at 2 kw, the larger 1.5 Mev at 15 kw. Output of the larger unit is equivalent to approximately 1 Mc of cobalt-60 and, when converted to x-rays, to radiation from 300,000 c of cesium-137. The service is available on either a single or sustained basis. Research assistance can be provided. (Radiation Dynamics, Inc., Dept. 861)

■ INFRARED SPECTROPHOTOMETER scans a spectral range from 1.0 to 15.5 μ with NaCl optics and a range from 0.5 to 38 μ with other available prisms. With NaCl optics accuracy of ± 0.015 μ and reproducibility of ± 0.005 μ are claimed. Resolving power is 0.02 μ at 12 μ. Stray radiation is less than 2 percent at 15 μ with filter. Transmittance reproducibility

is ±0.5 percent. The instrument, of the double-beam, automatic-recording type, features automatic gain control and programmed scanning speed to obtain maximum information under different energy conditions. In automatic mode of operation, the instrument returns to its starting point and stops after completion of scan. In cycle mode, the instrument repeats the scan as many times as desired for observing changing spectra. (Perkin-Elmer Corp., Dept. 860)

■ MAGNETIC RECORDER for use in seismic exploration provides 24 data channels, one timing channel, and two auxiliary channels. The recorder operates on 12-v d-c power and requires a 0.5-ma signal for full modulation. Response is essentially flat from 20 to 200 cy/sec and is phase corrected within 1 msec over this range. A built in frequency standard monitors motor drive and timing signals. No warm-up before operation is required. The complete system weighs 60 lb. Techno Instrument Co., Dept. 855)

■ OPTICAL CELLS consist of **U**-shaped Vycor body with fused-on silica optical windows. Spectral range is 185 to 3500 mμ. Transmittance at 220 mμ with a cell filled with double-distilled water is greater than 70 percent. The length of the light path is within ±0.5 percent of nominal path length, which may be 5 or 10 mm. Cells are furnished only in sets matched to within 2-percent transmission at 240 and 270 mμ and to within 3 percent at 220 mμ. (Beckman Instruments, Dept. 853)

■ SIGNAL SOURCE is remotely tunable over the frequency range 100 to 16,000 Mcy/sec. Power output varies from 500 to 5 mw over this range. The tuning unit may be 2000 yd or more distant from the source; it is connected to the source by one shielded pair of wires, one two-conductor coaxial cable, and three single-conductor wires. For square-wave modulation an additional single-conductor coaxial cable is required. (Scientific-Atlanta Inc., Dept. 858)

■ VOLTAGE COMPARATOR trips a relay output when the unknown input signal exceeds the reference input. The completely transistorized device has overload capacity 1000 times rated sensitivity. Repeatability of trip point is ±1 mv. Sensitivity is 5 mv a-c, 10 mv d-c. Input impedance is 2 megohm. Power required is 1 w with relay operating and 0.1 w with relay not operating. Weight of the device is 12 oz. (Trio Laboratories, Inc., Dept. 865)

■ SWEEPING OSCILLATOR covers the range from 100 kcy to 225 Mcy/sec in six bands. Sweep is effected electronically, and automatic-gain-control circuits maintain output constant within ±0.4 db. Eighteen crystal-controlled pulse markers, three in each band, provide frequency calibration. Sweep rate is variable around 60 per second and locks into line frequency. With sweep width reduced to a minimum, the instrument can be used as a continuous-wave signal generator. (Kay Electric Co., Dept. 843)

■ TISSUE FREEZE-DRYER for histochemical applications uses a condenser that completely surrounds the specimen. Specimens rest on a screen which permits unrestricted evaporation of molecules in all directions. Drying time for 2-mm-thick specimens is 6 hr. The temperature-control system permits selection of drying temperature. After drying, specimens are embedded in paraffin without breaking the vacuum. Evacuation is accomplished by a small combination mechanical pump and diffusion pump; liquid nitrogen is the condenser coolant. Canal Industrial Corp., Dept. 867)

JOSHUA STERN
National Bureau of Standards, Washington, D.C.

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Biochemist, Ph.D. Administrative, pharmaceutical, clinical research and development, 17 years; publications, anticarcinogenesis, enzymes, tracers, chemotherapeutics, antibiotics, immunnochemistry. Desires supervisory research position, industry or hospital, East. Box 144, SCIENCE. X

Botanist, Ph.D. Genetics, biology, general zoology, plant anatomy, microtechnique, human anatomy; research in air pollution and teaching experience. 40 years old. Wants teaching or research, small college preferred. Box 115, SCIENCE. 5/29; 6/5

Botanist-Plant Physiologist. Cornell Ph.D. Academic and agricultural teaching–research-administrative experience. Available September. Publications. Box 127, SCIENCE. 6/5

Clinical Chemist (female); 10 years' experience; M.S. Seeks Ph.D. plus opportunity to earn maintenance simultaneously. Box 129, SCIENCE. 6/12

Clinical Chemist, Physiologist, Ph.D. Chief, biochemistry division 600-bed university hospital. Research cardiac metabolism; some teaching. Will relocate similar position East or West. Box 142, SCIENCE. X

Clinical Psychologist, young, single Belgian female, wide varied experience, 15 months' graduate study with renowned specialists in U.S., desires to emigrate. Prefers Florida, West, or Southwest. Box 131, SCIENCE. 6/5

Microbiologist, Ph.D., general, environmental, pathogenic bacteriology; 12 years' teaching-research experience. Publications. Desires teaching-research position. Box 132, SCIENCE. 6/5

Ph.D. Environmental physiology, cellular physiology, and endocrinology. Also most vertebrate and beginning courses; 7 years' teaching and research. Societies and publications. Desires appointment by February. Box 141, SCIENCE. X

Virologist. Ph.D. Competent in virology, tissue culture, and phages. Broad experience in medical bacteriology, mycology. Desires research position. Box 138, SCIENCE. 6/12, 19

Zoologist (physiology). Completed graduate work leading to Ph.D., fall 1959. Desires teaching position with or without research in eastern college or university. Box 137, SCIENCE. X

POSITIONS OPEN

Bacteriologist. Ph.D. or M.D. with training and interests in tuberculosis for research associateship in broad program on the biology and therapy of pulmonary disease in man and subhuman primates. Reply to Director, The Christ Hospital Institute of Medical Research, Cincinnati 19, Ohio. 6/12

Biochemist for research on arthritis started by the late Lester Yoder. Part-time work, retired or semiretired person will do. Box 136, SCIENCE. X

POSITIONS OPEN

Biochemist, Physiologist or **Biologist** with strong biochemical interests, recent or 1959 Ph.D., desired to participate in basic research on cellular metabolism and renal transport mechanisms. May Institute for Medical Research, 421 Ridgeway Avenue, Cincinnati 29, Ohio. 6/5, 19

Biochemist Physical, Ph.D. To participate in USPHS research program (3-year grant) dealing with study of plasma proteins with physical-chemical techniques, for example, ultracentrifugation, chromatography, light scattering, and so forth. Salary, $8000 plus annual $500 increment. New York City area. Address replies to Box 118, SCIENCE. 6/5

(a) **Biochemist;** Ph.D. to head clinical chemistry laboratories, teach technologists, establish new procedures, some research opportunity; new biochemistry laboratories now being constructed; hospital will be 400 beds by late 1959; to $12,000, excellent potential; midwestern capital, college city. (b) **Bacteriologist;** M.S., Ph.D., to head department in busy laboratory, 550-bed fully approved hospital; southeastern resort area. (c) **Biochemist;** Ph.D. to help set up new laboratory in expanding hospital; now 175 beds; New England college city 40,000. (d) **Bacteriologist;** M.S., Ph.D., experienced in clinical bacteriology administration; head department in new 400-bed hospital to open soon; opportunity for teaching, research; popular Florida resort location. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

Biochemist wanted to head biochemistry division of research department at leading specialty hospital. Address inquiries to Mrs. Carol Martin, Secretary, Department of Research, 218 Second Avenue, New York 3, N.Y., or call ORegon 4-6760. 6/12

CLINICAL INVESTIGATION

Large Midwest ethical pharmaceutical company has opportunity for physician in department of clinical investigation; prefer man 30 to 40 with some experience past internship; training in nutrition and metabolism desirable though not necessary. Please send complete résumé to

Technical Employment Coordinator
The Upjohn Company
Kalamazoo, Michigan

The Institute of Marine Science of the University of Texas at Port Aransas announces a vacancy in the permanent position in **Marine Botany** open in the fall. Duties: conducting basic research in marine botany with emphasis on published results and graduate teaching in the summer. Requirements: Ph.D. in botany, training in algology, and some interests in functional processes in marine environments. Rank and salary dependent on experience. Applicants should send transcripts, qualifications, publications, and a statement of research interests to the director at Port Aransas, Texas, H. T. Odum. 6/5

Instructor, A.M. in Biology, to supervise general biology and inorganic chemistry laboratories. To teach comparative anatomy; small classes; 16 contact hours. Junior college in New England with strong liberal arts program. Start September 1959. Send credentials. Box 139, SCIENCE. X

Man wanted to cover selected and profitable territory for specialty firm in Midwest. Must have some laboratory background and desire to sell. Products now servicing more than 11,000 laboratories in the United States providing a positive labeling system for laboratories and institutions. Box 60, SCIENCE. 6/5, 19

New World-Wide Graduate Award Directories for American scientists, teachers, librarians to subsidize their education and research. Stipends $200–$10,000. Volume I (1957), $3; volume II (just published, no duplication), $3; both volumes, $5. Limited editions. Complete, specific information on 400 awards in United States and overseas in each volume. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. eow

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MICROBIOLOGISTS

Challenging positions in the Northeast and Midwest for microbiologists at all degree levels. Applicants should have 2 to 10 years of experience in fermentation research or production. Please reply to:

BOX 143, SCIENCE

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Young Ph.D.-level chemist, preferably with several years of industrial experience in tablet research and development to supervise tablet section in our product development department.

In confidence send complete résumé and salary requirements to

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Ph.D., interested in parasitology, medical entomology, and tropical medicine. Postdoctoral trainees at $4800 to $5600 per annum. Apply to Dr. Irving Fox, School of Tropical Medicine, San Juan 22, Puerto Rico. X

Physical-Analytical Chemist, Ph.D. or equivalent, to do collaborative and independent research in an established physical chemistry group. Emphasis on investigation and adaptation of newer analytical techniques to solution of pharmaceutical research problems. Important—experience in, or desire to learn, several fields of laboratory instrumentation. Ability to assume responsibility for gas chromatographic research of immediate value. Position offers fine opportunity for growth. Write to the Employment Division, Abbott Laboratories, North Chicago, Illinois. 6/5

Physician, not over 35, male, single or married. Experience not necessary. Salary open. M.D. licensed in Illinois (will accept M.D. who is eligible to receive license in Illinois). Applicant must have interest in blood bank work, including whole blood, plasma and serums, and clinical laboratory methods. Opportunities for research. Eventually can become associate director to present medical director. Box 135, SCIENCE. 6/12, 19, 26

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For development and testing in Polarization, Ellipticity, Retardation of Light, Electro and Magneto Optics, Optical Design.

Please forward resume to O. C. Rudolph & Sons Inc., P.O. Box 446, Caldwell, New Jersey.

POSITIONS OPEN

Plant Pathologist; Ph.D. to be project leader of fungicides and nematocides laboratory whose primary function is screening and evaluationg for new candidate pesticides. Biochemistry, fungus physiology, and/or plant physiology are desirable minor disciplines which aid the professional biologist in contributing to successful synthetic research program. Write Research Director, Niagara Chemical Division, Middleport, New York, for application for employment blank.
eow tf

Radiobiologist, an unusual opportunity for a Ph.D. of several years experience. Applications will be considered from personnel in allied sciences who are strongly interested in biomedical aspects of ionizing radiation. Salary range $7000 and up per annum. Location in Southwest university town of 200,000, low cost living, abundant recreation facilities. Box 122, SCIENCE.
6/5

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5 June 1959

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BUSINESS REPLY MAIL
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Readers' Service

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Room 740
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New York 36, New York

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Staple, Tape, Glue

5 June 1959

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☐ 1509*	☐ 1510	☐ 1511	☐ 1512,A	☐ 1512,B
☐ 1512,C	☐ 1513*	☐ 1514	☐ 1515	☐ 1516
☐ 1518	☐ 1555,U	☐ 1555,L	☐ 1556,UO	☐ 1556,LO
☐ 1557	☐ 1558,UI	☐ 1558,UO	☐ 1558,L	☐ 1559
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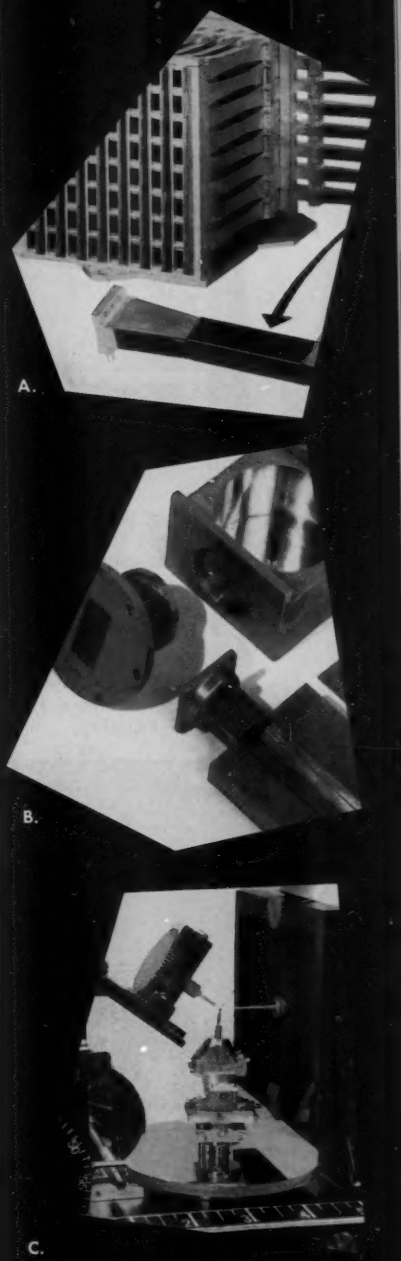

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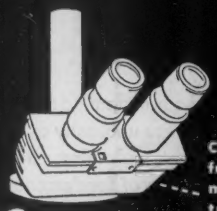

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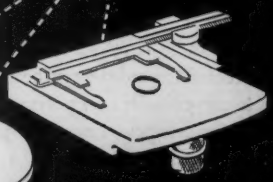

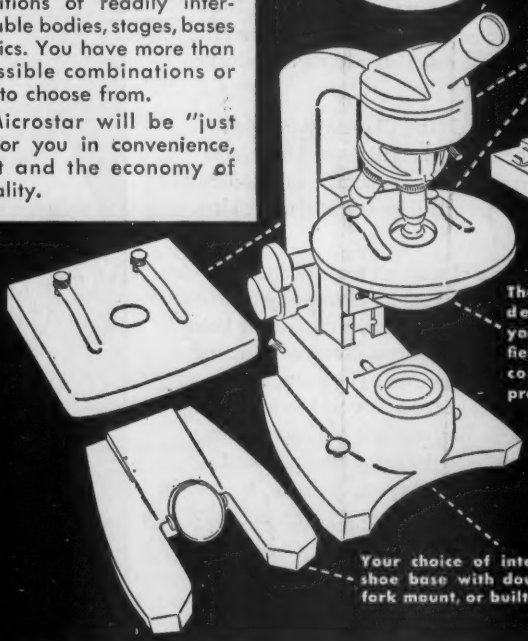

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